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KEITHLEY INSTRUMENTS

INSTRUCTION MANUAL

MODELS 121, 121R

TRUE RMS

WIDEBAND VOLTMETERS

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SECTION 1. GENERAL DESCRIPTION

1-1. GENERAL.

a. The Keithley Model 121 True RMS Wideband Voltmeter measures complex ac voltages from 15 cps to 50 megacycles. Between 20 cps and 10 megacycles, its accuracy is within 1%. The Model 121 measures true root-mean-square values from one millivolt full scale to 300 volts. Specified accuracy is maintained for wave forms with crest factors of six at full-scale deflection and 60 at one-tenth scale deflection. In addition, the 50-megacycles bandpass of the Model 121 minimizes errors due to attenuation of harmonics.

b. The Model 121 can also be used as a preamplifier with a usable frequency response from 10 cps to 100 megacycles, a gain of 100, a rise time of less than six nanoseconds and noise of less than 70 microvolts rms. A dc output voltage, proportional to the square of the ac input and 100 millivolts at full scale on any range, is also available.

1-2. APPLICATIONS. The Model 121 can be used to measure sinusoidal and complex voltages, noise in components, white noise in electronic equipment, and wave form distortion; investigations in vibration, sound and optics; and calibration of other ac equipment.

1-3. DIFFERENCES BETWEEN THE MODELS 121 AND 121R.

a. The Model 121R is the rack version of the cabinet configuration, Model 121. The circuits, specifications, electrical parts and operating procedures for the two models are the same, except for the outside dimensions.

b. The instructions in the Manual are for both models, although only the Model 121 is mentioned. Any differences are identified for the correct model.

1-4. ACCESSORIES.

a. The Model 121 can be used with three probes, which increase the input impedance of the Voltmeter and make many measurements more convenient. Descriptions, specifications and operating instructions for the probes are given in Section 5.

b. The Model 1205 Accessory Kit contains adapters, cables, a filter and a termination for use with the Model 121. The kit is described in paragraph 5-6.

1-5. SPECIFICATIONS.

VOLTMETER CHARACTERISTICS

FREQUENCY RANGE: 15 cps to 50 megacycles.

ACCURACY: ±1% of full scale, 20 cps to 10 megacycles.
±3% of full scale, 18 cps to 20 megacycles.
±5% of full scale, 15 cps to 50 megacycles.

Note: Meter tracking error may contribute an additional ±1/2% of full scale error to the accuracy specification.

VOLTAGE RANGE: Full-scale readings of one millivolt to 300 volts in 1x and 3.16x steps over 12 ranges.

MAXIMUM PERMISSIBLE OVERLOAD: 50 volts rms on 1-millivolt to 100-millivolt ranges, increasing to 500 volts rms on 300-volt range. 400 volts dc on all ranges.

INPUT NOISE: 70 microvolts rms, maximum.

METER SCALES: Two approximately linear scales, 0 to 3 and 0 to 10, calibrated in true rms. Db scale calibrated from 0 to 10 db.

CREST FACTOR: Six at full scale, 12 at half scale, 60 at tenth scale, etc.

AMPLIFIER CHARACTERISTICS

AC OUTPUT (proportional to input):

RISE TIME (10% to 90%): Six nanoseconds, maximum.

OUTPUT VOLTAGE: Unterminated, approximately 100 millivolts rms at full scale on all ranges.

MAXIMUM GAIN: Unterminated, approximately 100.

OUTPUT IMPEDANCE: Approximately 100 ohms.

DC OUTPUT (Proportional to square of input):

OUTPUT VOLTAGE: Unterminated, approximately 100 millivolts dc at full scale on all ranges.

OUTPUT IMPEDANCE: Less than five kilohms.

GENERAL CHARACTERISTICS

INPUT IMPEDANCE: One megohm shunted by 20 picofarads.

LINE STABILITY: Variations on the 1-millivolt range are within 0.5% for line voltage changes between 105 and 125 volts; on higher ranges, variations are less.

CONNECTORS: Input and AC Output: uhf-type receptacles. Ground binding post.
Dc Output: Binding posts.

TUBE COMPLEMENT: Three 7586.

TRANSISTOR COMPLEMENT: One 2N1142, five 2N1183, four 2N1381, one 2N1535, five 2N2594, six 2N651.

POWER: 105 to 125 volts or 210 to 250 volts, 60 cps, 50 watts. 50-cps models on order.

ACCESSORIES SUPPLIED: Mating uhf-type plugs; binding post adapter.

DIMENSIONS: Model 121: 11-1/2 inches high x 7-1/4 inches wide x 13-3/4 inches deep.
Model 121R: 5-1/4 inches high x 19 inches wide x 13-1/2 inches deep.

NET WEIGHT: Model 121: 17 pounds.
Model 121R: 17-1/2 pounds.

1-6. EQUIPMENT SHIPPED. The Model 121 True RMS Voltmeter is factory-calibrated and is shipped with all components in place. The shipping carton contains the Instruction Manual, two Teflon-insulated uhf-type plugs and a binding post adapter. The Model 121R shipping carton also contains a pair of angles which screw on the instrument for use in rack mounting.

SECTION 2. OPERATION

2-1. FRONT PANEL CONTROLS AND TERMINALS.

a. POWER SWITCH. The Power switch is a toggle switch which turns the Model 121 on.

b. RANGE SWITCH. The Range switch selects one of the 12 ranges in 1x and 3.16x steps from one millivolt to 300 volts full scale. The reading is made directly from the meter for the range being used.

c. ZERO CONTROL. The ZERO potentiometer adjusts the meter to zero for no input signal. This control should be used on only the 300-volt range.

d. PILOT LIGHT. The green pilot light is in series with the Nuvistor tube, so the instrument will not operate if the light is out.

e. PROBE CONNECTOR. The PROBE receptacle is the power outlet for the Model 1201 Cathode Follower Probe. It provides -12 volts dc filament power for the vacuum tube in the probe.

f. INPUT. The INPUT is a uhf-type receptacle. The ground post, G, is connected to the chassis.

2-2. REAR PANEL CONTROLS AND TERMINALS.

a. POWER CORD. The Model 121 is for a 105-125 volt, 50-400 cps line source, unless otherwise specified on the rear panel. A 3-wire power cord is used.

b. PROBE CALIBRATE CONTROL. This control, marked PROBE CAL, compensates for the input loss in the Model 1201 Cathode Follower Probe circuit. The control adjusts the meter only when the probe is connected; it will not affect the calibration of the meter when the Model 121 is used without a probe.

c. AC OUTPUT. The uhf-type AC OUTPUT receptacle supplies 100 millivolts ac at a full-scale meter reading into an open circuit on all ranges. Output impedance is 100 ohms.

d. DC OUTPUT. The DC OUTPUT receptacle supplies 100 millivolts dc at a full-scale meter reading into an open circuit on all ranges. Output resistance is less than five kilohms.

e. CALIBRATION SIGNAL. The calibration signal, a 200-cps square wave, is calibrated to furnish full-scale deflection on the 10-millivolt and 10-volt ranges.

f. FUSE. For 105-125 volt operation, the Model 121 uses an 0.75 ampere, 3AG fuse; for 210-250 volt operation, the Model 121 uses an 0.38 ampere, 3 AG fuse. The fuse is removed by unscrewing the cap and pulling out the fuse holder.

NOTE

Controls marked on the bottom panel are adjusted only for high-frequency calibration as described in paragraph 4-8.

2-3. VOLTMETER OPERATION.

a. Connect the power cord to a 105-125 volt, 50-400 cps source unless the Model 121 rear panel is marked for 210-250 volt operation. Turn the power switch to ON and allow the instrument to warm up for 15 minutes. Set the Range switch to the 300-volt range and adjust the meter to zero with the ZERO control.

b. Connect the signal source to the INPUT receptacle. Cabling is very important in measuring high-frequency signals; refer to paragraph 2-11 for suggestions to improve hookups. Switch the Range switch down to the most sensitive range for the input signal.

c. When using the 1- and 3-millivolt ranges, the noise inherent in the Model 121 will affect readings. Maximum input noise is 70 microvolts, which is present as an upscale deflection on the meter. This amount should be subtracted from the meter reading for these ranges. Readings below will not be within the instrument's specified accuracy.

2-4. DECIBEL MEASUREMENTS. The decibel scale of the Model 121 allows the voltage ratio to be measured directly in decibels. The scale can be used over all 12 ranges. The ratio between two voltages is given by

$$(-v_1 + v_2 \pm 10\ n)\ db$$

where v_1 is the decibel reading of the first voltage;
v_2 is the decibel reading of the second voltage;
n is the number of ranges on the instrument between the two readings.

The number is positive if the ranges increase from the first to the second voltage, and it is negative if the ranges decrease.

Example: When the Range switch is on the 1-volt range, a reading of 4 db is obtained. When the Range switch is set three ranges higher on the 30-volt range, a reading of 3.2 is obtained. The ratio between the two voltages is

$$(-4 + 3.2 + 10 \times 3)\ db \text{ or } 29.2\ db$$

DB	VOLTAGE RATIO	POWER RATIO
0	1.00	1.00
0.5	1.06	1.12
1.0	1.12	1.26
1.5	1.19	1.41
2.0	1.26	1.58
3.0	1.41	2.00
4.0	1.58	2.51
5.0	1.78	3.16
6.0	2.00	3.98

7.0	2.24	5.01
8.0	2.51	6.31
9.0	2.82	7.94
10	3.16	10.0
15	5.62	31.6
20	10	100

TABLE 2-1. Decibel Relationships to Voltage and Power Ratios. The Voltage Ratio is the value in volts if the reference level is one volt. The Power Ratio gives the value in milliwatts if the reference level is one milliwatt.

2-5. AMPLIFIER OPERATION. The Model 121 provides both an ac and a dc output voltage.

a. Ac Output.

1. The Model 121 can be used as a preamplifier or as an attenuator for other instruments. A uhf-type receptacle is on the rear panel, and it furnishes a signal without disturbing the operation of the meter. The amplifier will supply 100 millivolts rms, open-circuited at full-scale meter indication on any range; the output impedance is 100 ohms.

2. Signal transmission and connection techniques for the output are similar to those for use as a wideband voltmeter. Refer to paragraph 2-11.

3. Connect the Model 121 and other associated equipment, such as an oscilloscope, on the same power line to avoid ac ground loops. Otherwise, the output signal from the Model 121 will tend to be modulated by the ground loops.

b. Dc Output.

1. The Model 121 provides a dc signal proportional to the square of the input up to 100 millivolts for a full-scale meter deflection on any range. The signal is intended for use with chart recorders or digital equipment. Normal recorder connection techniques are required to utilize this output.

2-6. USE OF CALIBRATION SIGNAL.

a. To quickly check the Model 121, the calibration signal available on the back panel may be used. These signals may be used to determine if the instrument is operating properly; however, this check is not to be substituted for standard calibration of the Model 121 given in Section 4.

b. Set the Range switch to 1- millivolts and zero the meter. Connect the INPUT to the 10 MV calibration signal. Use a shielded coaxial cable for connecting the input and the calibration signal. The meter should read full scale, 10 millivolts. A similar check can be made on the 10-volt range using the 10V calibration signal. All voltage ranges are effectively checked using the two calibration signals.

2-7. ACCURACY CONSIDERATIONS. In high-frequency measurements, other considerations affect the accuracy of a measurement besides the voltmeter. The voltmeter can only read the signal received at its input terminal; therefore, it is important that this signal be the same as that of the source. The following paragraphs list points to consider during a measurement to increase the accuracy of the reading. Since it would take a considerable volume to carefully examine each point, these paragraphs should serve as a checklist. Points considered are crest factor, dc voltage, loading effects, ground loops, cabling, signal pickup and stray fields.

2-8. CREST FACTOR. The Model 121 has a crest factor of six at full scale. This means that it can accurately measure signals with peak values as high as six times their rms value. Also, the Model 121 has a 50-megacycle bandpass. This means it will minimize inaccuracies due to harmonic attenuation.

2-9. DC VOLTAGES. The Model 121 is rc-coupled and is designed to give the rms voltage of the ac component of a signal from a direct meter reading. To obtain the total rms voltage of a signal having a dc component, additional steps are necessary.

1. Measure the dc component of the signal with a narrow band dc voltmeter.

2. Add the ac and the dc components according to the following formula:

$$E_t = E_{dc}^2 + E_{ac}^2 \qquad \text{Eq. 1}$$

where E_t is the total rms voltage;
E_{dc} is the dc components in dc volts as read by a dc voltmeter;
E_{ac} is the ac component in rms volts as read by the Model 121.

2-10. LOADING EFFECTS.

a. The input impedance of the Model 121 must be high relative to the impedance of the source. If the two approach each other in value, a significant portion of the source voltage is dropped across its own internal impedance. In general, the voltage read by the meter is

$$E_m = \frac{Z_m}{Z_o + Z_m} E_o \qquad \text{Eq. 2}$$

where E_m is the voltage read by the Model 121;
E_o is the source voltage;
Z_m is the Model 121 input impedance, one megohm, 20 picofarads;
Z_o is the source impedance.

At low frequencies, the source impedance should be less than 10 kilohms to avoid an error in reading of less than 1%.

Frequency	Model 121 Input Impedance
100 cps	10^6 ohms
1 kc	9.5×10^5 ohms
10 kc	6.2×10^5 ohms
100 kc	7.95×10^4 ohms
1 Mc	7.95×10^3 ohms
10 Mc	7.95×10^2 ohms
50 Mc	1.59×10^2 ohms

TABLE 2-2. Frequency vs. Input Impedance of Model 121.

b. As frequencies increase, the Model 121 input capacitive reactance decreases. Therefore, to minimize circuit loading of the test setup, every effort must be made to minimize added input capacitance or to reduce the source impedance. Input capacity will decrease by using cables which are as short as possible or by using one of several accessory probes available. The effective source impedance may also be reduced by using a terminated coaxial system, usually terminated at 50 ohms.

2-11. GROUND LOOPS. A common source of errors when making low-level measurements is ground loops. This is a current of signal -- line or other frequency -- flowing in a ground lead impedance, which results in a voltage in addition to the desired signal voltage appearing at the input terminals of the voltmeter. Although the origin and mechanism of ground loops are difficult to explain and trace, their effects can be reduced in several ways.

a. Eliminate unnecessary grounds by using a 3 to 2 prong adapter to lift the instrument case from power system grounds.

b. Use a low-capacitance, high insulation-resistive isolation transformer between the power line and the voltmeter.

c. Make all ground lead impedances as low as possible.

d. Employ, as far as possible, only coaxial connecting leads in the signal circuits leading to the voltmeter input terminals.

2-12. CABLING CONSIDERATIONS.

a. In high-frequency work, proper transmission lines and connections become an important part of the system. If transmission lines or connections are improper, reflections, standing waves or undue loading on the source may cause errors in the measurement. If it is necessary to use other than 50-ohm cables, suitable matching devices should be used to couple between cables or inputs having different characteristic impedances. Keep all transmission lines as short as practical to minimize cable losses.

b. Reflections and standing waves can introduce significant errors into a measurement setup, particularly if the measured frequency is above a few megacycles. As a wave travels down a transmission line, it generates a reflection each time it encounters a mismatch or impedance difference. The reflec-

tion travels back along the line to the signal source where it either adds to or subtracts from the input signal at that instant. The amplitude and polarity of the reflection depend upon the nature of the mismatch which caused the reflection. Standing waves may also be introduced if the transmission line is of appreciable length compared to the wave length being measured. In general, to reduce inaccuracies due to reflection and standing waves, use a terminated coaxial system. Special care should be given to proper matching and cable length.

c. Another factor that may be important is the finite time delay produced by the cables. This is especially important when using the Model 121 as a preamplifier for making time-difference measurements between two signals. In this case, each signal should travel through cables of identical characteristics (i.e., length and characteristic impedance) in order to observe their time relationships.

2-13. RESONANCE. Inaccuracies may be introduced by resonance at the input of the Model 121 due to shunt capacitance and series inductance. The occurance of resonance becomes more likely as series inductance is increased usualy cable inductance and measured frequencies become higher. To minimize the occurance of resonance, use connections and cabling of minimum inductance. A special case where resonance may be a problem is when the Model 1201 Probe is used. Avoid lengthening the ground cable of the Model 1201. At very high frequencies, it may sometimes be necessary to replace the Model 1201 ground cable with a ground cable of less inductance, i.e., decrease the length or increase the other physical dimensions. Usually, the resonant point of a terminated coaxial system is at a frequency too high to affect the Model 121's accuracy.

2-14. SIGNAL PICKUP. Unwanted signals, such as 60 cps pickup, may be picked up directly by the Model 121. This source of inaccuracy becomes more significant as measurements become more sensitive and source impedances become higher. To reduce the inaccuracies due to unwanted pickup, use appropriate electrostatic or magnetic shielding. The type of shielding used and its physical configuration will vary with individual measurement circumstances.

2-15. STRAY FIELDS. Stray fields can induce unwanted emfs in the test system. The inaccuracies due to these fields become more significant as measurements become more sensitive. Induced emfs may be reduced by using coaxial cable having minimum loop area and by using cables of minimum length.

SECTION 3. CIRCUIT DESCRIPTION

3-1. GENERAL. The input signal is transmitted through the attenuator circuits and the cathode followers to the wideband transistor amplifiers. Gain stabilization is achieved by over 100 decibels of negative feedback. After amplification, the signal is fed into the thermal converter circuit. This circuit employs a thermocouple and a chopper-stabilized amplifier; it is self-balancing with the output voltage of the thermocouple always maintained at a constant level. With no applied ac signal, the thermocouple output is maintained by applying a dc bias current to its heater. When an ac signal is applied to the heater, its heating effect unbalances the circuit. Balance is restored by reducing the quiescent bias current. The change in bias current is proportional to the rms value of the applied ac signal and is read directly on the meter. A second thermocouple serves as an ambient temperature compensator.

3-2. CIRCUITS BY RANGE (Refer to schematic 15760E for circuit designations).

a. The Model 121 is composed of several basic elements: attenuators, cathode followers, amplifers, thermal converter, metering circuit and power supply. The range in use determines which elements are operating. The circuits for each range are designed to provide a 300-millivolt rms signal at the input of the thermal converter for a full-scale meter reading. Fig. 3-1 illustrates the circuit through the voltmeter for each of the 12 ranges. Selection of the attenuators and amplifiers is through the operation of the Range switch S1. The ac output amplifier, the thermal converter, the metering circuit and the power supply are used for all ranges.

b. For the 1-millivolt range, both amplifiers are used and the total gain is such that no attenuation is required. If each amplifier, cathode follower and associated wiring are grouped together, the approximate gains for the amplifiers are 17 and 24, respectively.

c. The interstage attenuator is used for the 3-, 10- and 30-millivolt ranges. For these ranges, the input impedance of the voltmeter is determined by the input capacity to the input cathode follower, V1, and the miscellaneous stray capacities in parallel with the 1-megohm grid resistor, R113.

d. On all ranges greater than 30 millivolts, the preamplifier is not used, and input attenuator no. 2 is inserted before the ac output amplifier. Ranges above 3 volts use the 100:1 input attenuator no. 1 and input attenuator no. 2.

3-3. ATTENUATORS. (Refer to schematic 15760E for circuit designations)

a. The input attenuators were designed to maintain a 1-megohm input resistance on all voltage ranges without degrading amplifier response or accuracy. Precision metal-film resistors are used for all attenuators, shunted where necessary by fixed or variable capacitors. The variable capacitors permit an independent adjustment of high frequency attenuation on each range, thereby compensating for resistor and wiring variations within each instrument.

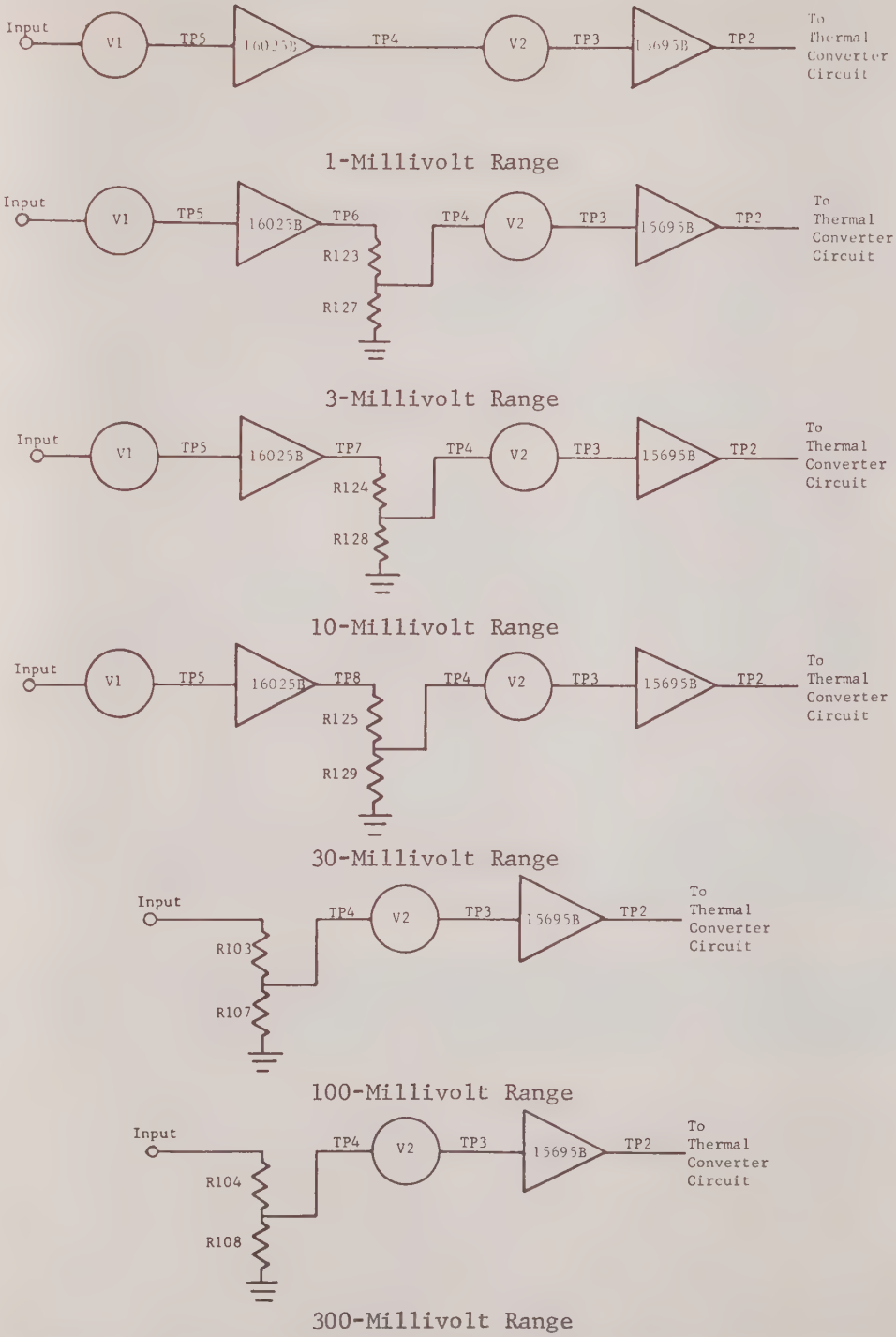


FIGURE 3-1 (Sheet 1). Model 121 Circuit by Range.

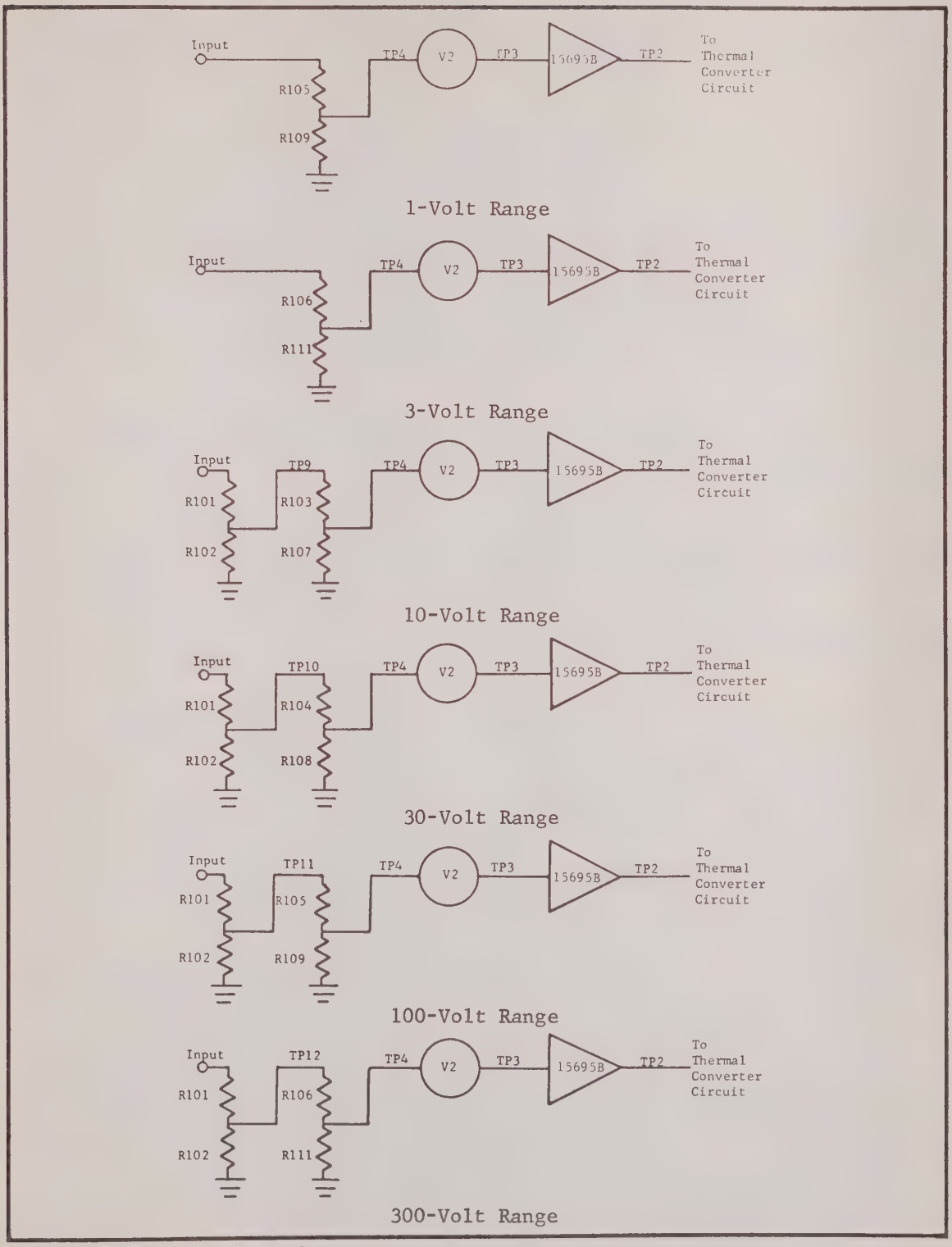


FIGURE 3-1 (Sheet 2). Model 121 Circuit by Range.

b. The resistors which comprise input attenuator no. 1 are R101 and R102. Input attenuator no. 2 consists of resistors R103 through R111. The interstage attenuator consists of resistors R123 to R125 and R127 to R129. Variable capacitors shunt most of the resistors.

3-4. CATHODE FOLLOWERS. Nuvistor tubes were selected for the cathode followers, V1, V2 and V3, to provide high impedance matching and to protect the instrument from excessive input signals. On the four most sensitive ranges, the input signal is directly into V1. On these ranges, the input will withstand overloads of 50 volts rms. Overload protection increases on the other ranges to a maximum of 400 volts rms on the 300-volt range, thus protecting the solid state components within the instrument. The high-impedance tube characteristic insures a stable, passive input, thus avoiding high-frequency resonance between the measuring circuit and the source.

3-5. AMPLIFIERS.

a. The Model 121 uses two amplifiers: a preamplifier, the 16028C and an ac output amplifier, the 15696C . Each amplifier is contained on a plug-in module.

b. Fig. 3-2 shows the basic amplifier stage used in the modules. Resistors R_a, R_b and the collector load voltage drop provide a bias voltage stabilization. Resistor R_a supplied dc feedback; however, R_a also supplies ac feedback with a resultant degeneration of operation. To lessen this effect, R_a is divided into two equal parts, and the capacitor C bypasses the ac components from the midpoint of R_a to ground.

c. Negative feedback is used around all the amplifier stages of each module to maintain a constant reduced gain over the pass band of the amplifier. Since the gain bandwidth is the limiting factor for these amplifiers, reducing the gain maintains a flat response over a wider frequency range.

3-6. PREAMPLIFIER. (Refer to schematic 16028C for circuit designations)

a. The preamplifier consists of three stages described in paragraph 3-5, with a negative feedback circuit. The feedback resistors (R_a, Fig. 3-2 for each stage are R303 and R304, R310 and R311, R315 and R316. The ac bypass capacitors (C , Fig. 3-2) are C303, C306 and C307, respectively.

b. Resistor R317 samples the output voltage from the last amplifier stage. The feedback circuit back to the input transistor, Q11, is through the voltage divider, resistors R312 and R305. To compensate for losses which occur at high frequencies, the gain is increased by bypassing part of the negative feedback with trimmers C304 and C308. The trimmers also provide compensation for any stray capacitive negative feedback between the input and output of each amplifier.

c. Potentiometer R302 provides a small amount of low frequency coupling between transistors Q11 and Q12 to extend the lower limit of frequency response and to provide low frequency stability.

d. The gain of the preamplifier is adjusted through a network containing

potentiometer R121 (schematic 15760E). The range of adjustment of the potentiometer is purposely limited to that value needed for compensation to allow for accurate setting to the desired value.

3-7. AC OUTPUT AMPLIFIER (Refer to schematic 15696C for the circuit designations).

a. The ac output amplifier is designed to supply a maximum of 300 millivolts rms for a full-scale meter deflection to drive the low-impedance thermal converter and to maintain a crest factor of

b. The ac output amplifier consists of three stages described in paragraph 3-5, with a negative feedback circuit. The feedback resistors (R_a, Fig. 3-2) for each stage are R403 and R404, R411 and R412, R17 and R418. The ac bypass capacitors (C , Fig. 3-2) are C403, C406, and C408, respectively.

c. Resistor R419 samples the output voltage from the last amplifier stage. The feedback circuit back to the input transistor, Q1, is through the voltage divider, resistors R414 and R408. To compensate for losses which occur at high frequencies, the gain is increased by bypassing part of the negative feedback with trimmers C404 and C409. The trimmers also provide compensation for any stray capacitive negative feedback between the input and output of each amplifier.

d. Potentiometer R406 provides a small amount of low frequency coupling between transistors Q1 and Q2 to extend the lower limit of frequency response and to provide low frequency stability.

3-8. THERMAL CONVERTER CIRCUIT.

a. The thermal converter consists of a low impedance heater and thermocouple sealed in a glass envelope. Any ac or dc voltage applied to the heater results in a small dc output voltage from the thermocouple. The value of this small output voltage is proportional to the square of the effective value of the current flowing through the heater and it is not dependent on the shape or phase of the signal applied.

b. A high-gain chopper amplifier with feedback is used to increase the overall dc output voltage in order to drive a meter. The thermal converter is located in the dc feedback loop, where a rapid transit time from zero to full scale is obtained when a signal is applied to the instrument.

A quiescent (no signal) dc bias current is applied to the heater of the thermal converter. When an ac signal is applied to the heater, the overall heating effect tends to increase, raising the thermocouple's output voltage. This increased thermocouple voltage output causes the chopper amplifier to subtract dc current from the heater. Equillibrium occurs when the total ac and dc heating effect equals the initial no-signal (quiescent) dc level. The meter is placed in the feedback loop where it measures this displacement of dc current, which in turn is a function of the rms ac signal applied.

To compensate for variations in thermocouple output due to changes in

ambient temperature, a second thermal converter functions as a temperature compensator. Specifically, the temperature compensating thermal converter provides an overall temperature coefficient which is equal to that of the signal thermocouple. Its heater operates at a constant power; as the temperature increases or decreases, the equivalent voltage across both thermocouples with no signal remains at zero. The thermocouples are connected in series, but in opposite polarity to retain a null output across both when the temperature changes. A zero control is provided to give an even more accurate zero adjustment.

3-9. METERING CIRCUIT

a. The Model 121 uses a taut-band meter which has a square law response. By the nature of such a movement, a small amount of current will result in a relatively large downscale pointer movement, whereas an increasingly greater amount is needed to move the pointer the same per cent of full scale at higher readings. For example, 1% of full scale current will cause a 10% deflection of the meter. As a result, an apparently large zero drift may represent a very small current, the effect of which at readings of 3 or greater on the 10-volt scale is negligible.

A red band is marked on either side of the meter zero line. If, with no input signal, the pointer falls within the red area, measurements will be accurate to specification for readings of 3 or greater on the 10-volt scale. For measurements resulting in a deflection less than 3, care should be taken that the meter be accurately zeroed.

3-10. POWER SUPPLY (Refer to schematic 15760E for circuit designations).

a. The transistor-regulated power supply has line regulation of better than 0.001% and long term dc stability within 0.1%. Power dissipation and heating effects are minimized by the solid state design. The -12 volt dc output of the transistor regulator supplies the filaments of all thermionic devices used in the instrument. The power supply also furnishes -26 volts and +75 volts. All ac components in the power supply are minimized so that the instrument will not receive extraneous signals into the input. To accomplish this, the electronic regulator is designed with wide frequency response and capacity filtering is used throughout.

b. Unregulated voltage from transformer T1 is rectified by diodes D102 and D103 and then is filtered. The voltage is applied to the series regulator transistor, Q1. To obtain the stable -12 volt supply, the output of Q1 is sampled by the resistor string R210, R225 and R231, and is compared to the zener reference diode, D110. If a voltage difference exists, it is amplified by transistors Q5 and Q6, operating as a differential voltage amplifier. A dc amplifier Q4 further amplifies the error signal. Transistors Q3 and Q2 are cascaded current amplifiers with capacitor C204 serving as an ac bypass. The amplified difference signal is then applied to the base of the series regulator transistor, Q1. In this way, a stable voltage is furnished for the fialments. Also, since the pilot lamp, DS-1, is in series with the filament of Nuvistor tube V1, the voltmeter will not operate if the lamp is off.

c. An ac-to-dc converter is used to supply -26 volts and +75 volts for the

-12 volt supply. Transistors Q7 and Q8 form a switching network to supply an interrupted dc voltage to transformer T2. An extra winding from the transformer supplies feedback to the network to sustain switching action; resistor R212 determines the magnitude of the feedback. A filter, composed of resistor R221 and capacitor C207, prevents the introduction of spikes caused by the switching network into the -12 volt supply. A portion of the voltage from the switching network is supplied to the divider network, R222, R223, R224 and R228, to obtain the 10-millivolt and 10-volt calibration signals.

d. The +75 volt output is derived from the secondary of transformer T2 after it is rectified and filtered. Rectifiers D106 and D107 apply a voltage to a filtering network containing a transistor current amplifier, Q9. The base circuit of the transistor contains a capacitor filter network.

e. The -26 volt output is derived from transformer, T2, through a similar circuit. Transistor, Q10, is the current amplifier.

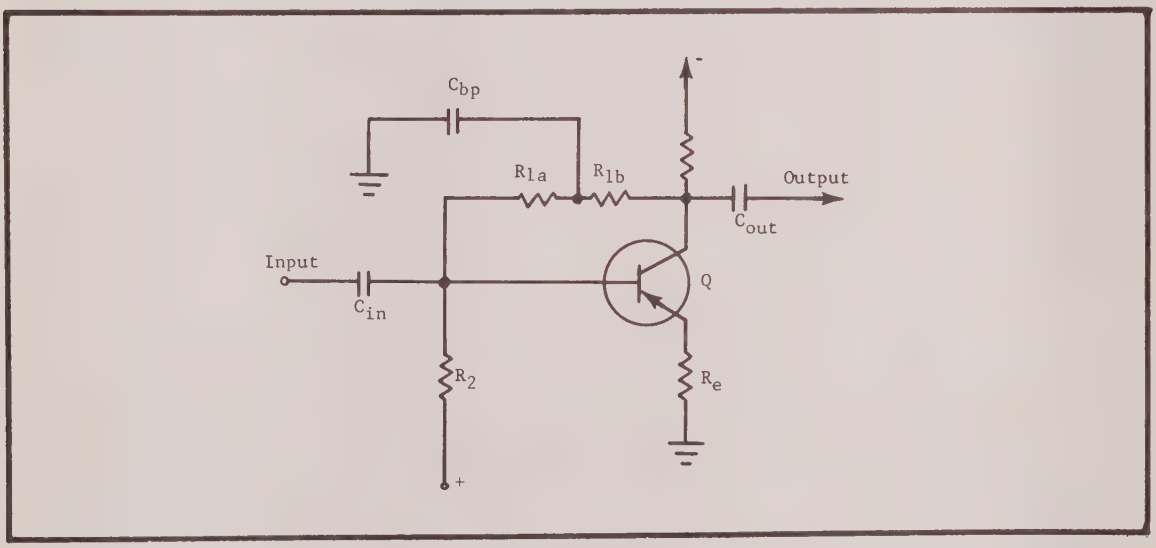


FIGURE 3-2. Basic Amplifier Stage.

CALIBRATION PROCEDURE

MODEL 121 TRMS WIDEBAND VOLTMETER

INDEX

121.1 Test Equipment

121.3 Preliminary Calibration Procedure

121.4 Final Calibration (100mv - 300v)

121.5 Final Calibration (1mv - 30mv)

121.6 Crest Factor

121.7 Calibration Adjustments

121.8 DC and AC Output

121.9 Trouble-Shooting Hints

121.1 Test Equipment

121.11 General Purpose Test Equipment

Conventional VTVM (RCA Volt - Ohmist)

D.C. Voltmeter (United Systems Z202A)

A.C. VTVM (HP 400 CD)

121.12 Special Purpose Test Equipment

Function Generator (HP - 202A)

Oscilloscope (Tektronix 503 or 561A)

Voltmeter Calibration (HP 738AR)

Oscillator (HP 200CD)

Oscillator (HP 200SR)

Frequency Response Test Set (HP 739AR)

Constant Amplitude Signal Generator (Tektronix 190B)

Power Amplifier (Boonton 230A)

121.13 Special Purpose Test Equipment

10DB & 20DB Attenuators (GR - 874 Type)

50 Ohm Terminations (GR - 874 & Bird 80-A)

Transfer Standard (Fluke 54A)

121.3 Preliminary Calibration Procedure

121.32 Power Supply

121.321 Connect 121 less plug-in modules to 110v/60cps. Check 12v supply. If supply is regulating, check +75v and -26v supplies.

121.322 Turn power off, plug in modules and turn power on again. Monitor -12v supply with digital voltmeter. Adjust R231 for -12v ±50 mv DC. Monitor -12v supply with scope. Power supply noise should be less than 8mv peak to peak. Check the +75v and -26v supplies.

Noise should be less than 5 mv peak to peak.

121.323 Line Regulation

Test the -12 volt supply for proper regulation by varying the line voltage from 100 to 140 volts AC. The -12 volts should remain constant ± 10 mv DC. Connect the 1201 probe and repeat test.

121.4 Final Calibration (100 mv through 300 volts)

121.41 Gain Calibration

Connect voltmeter calibrator with output at 1 volt ± .25% to the 121 input. Adjust R524, 1K trimmer pot located in TRMS module to obtain 1 volt full scale on the one volt range. Insure that meter zero is correct.

Change voltmeter calibrator output to 3 volts ± .25% and check 121 full scale accuracy on the 3 volt range for 3 volts ± .25%. Change R-112 (4.744K) if necessary to obtain correct accuracy.

121.42 Range Calibration

Check the 100 mv through 300 v ranges on the 121 for full scale deflection ± .25% using the voltmeter calibrator. Change range resistors if necessary to obtain rated accuracy.

121.43 Meter Tracking

Check the 1 volt and 3 volt ranges for proper tracking using the voltmeter calibrator. The meter tracking should be within ± .5% of full scale.

121.44 Frequency Response

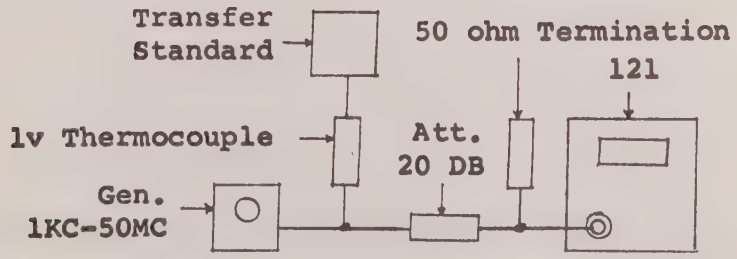
121.441 Low Frequency

Switch 121 to 100 mv range. Apply 90 mv (rms) at 1000 cps using constant amplitude function generator. Sweep to 20 cps. Adjust R-406, located in middle module, to 90 mv (rms). Sweep from 1 KC to 20 cps and check for a frequency response within ± 1%. Sweep to 15 cps. Frequency response at 15 cps should be within -5%.

For this instrument ±1% is ± 1 minor meter division, ± 3% is ± 3 minor meter divisions and ± 5% is ± 5 minor meter divisions.

121.442 High Frequency

121.4421 100 mv Range



Set up test equipment as shown above. Apply 90 mv @ 1000 cps to input of 121. Adjust the constant voltage source to obtain a null on the microvoltmeter.

121.4421 (continued)

Increase the sensitivity of the microvoltmeter up to 100 uv full scale. The reference level has been established for a 90% full scale reading at 1000 cps.

Apply a sufficient signal at 10 MCS to the input of the 121 to obtain a null on the microvoltmeter. Adjust C-105 on the 100 mv attenuator to obtain 90% of full scale meter reading.

Apply a sufficient signal at 21 MCS to the input of the 121 to obtain a null on the microvoltmeter. Adjust C-404 on the middle amplifier to obtain 90% of full scale meter reading.

Apply a sufficient signal at 45 MCS to the input of the 121 to obtain a null on the microvoltmeter. Adjust C-409 on the middle amplifier to obtain 90% of full scale meter reading.

Because of the inter-action of the controls, it will be necessary to adjust between C-105, C404 and C-409 to obtain the proper frequency response. The frequency response must be within $\pm$ 1% or $\pm$ 1 minor meter division from 1000 cps - 10 MCS; $\pm$ 3% or $\pm$ 3 minor meter divisions from 10 MCS to 21 MCS; and $\pm$ 5% from 21 MCS to 50 MCS when using a reference of 1000 cps.

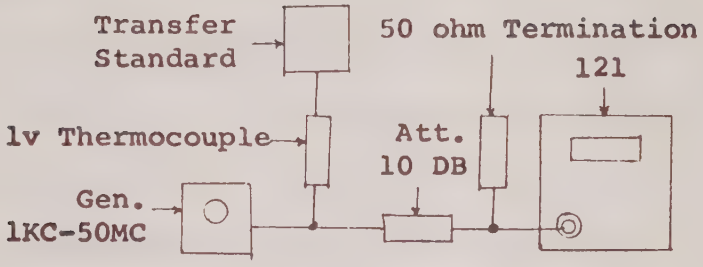
121.4421 (continued)

Since the 100 mv - 300 v amplifier is tuned only once (on the 100 mv range), the frequency response must be as good as possible to insure proper response on the remaining ranges. Typically, the frequency response on the 100 mv range from 10 MCS to 21 MCS should be within 1%, and the response from 21 MCS to 50 MCS within ± 2.5%.

After the C105, C404 and C409 are turned for the best possible frequency response, sweep from 1000 cps to 10 MCS to insure frequency response within ± 1%. Then check from 10 MCS to 50 MCS at 5 MC increments to insure response within ± 3% to 21 MC and within ± 5% to 50 MC.

The 100 mv range is calibrated.

121.4422 300 mv Range

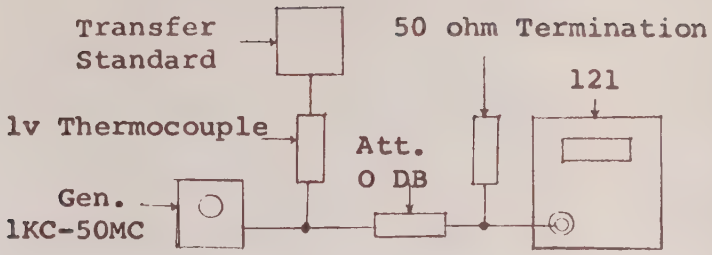


Set up test equipment as shown above. This step is similar to 121.4421, except apply sufficient signal to read 90% of full scale on the 300 mv range at 1000 cps. (Always use 0 - 10 scale for determining frequency response).

After reference level has been established at 1000 cps, adjust C106 to obtain 90% of full scale at 10 MCS within ± 1/2%.

Check frequency response from 1000 cps to 10 MCS to insure response within ± 1%, adjusting C106 only if necessary. Check frequency response from 10 MCS to 50 MCS at 5 MC increments to insure response within ± 3% to 21 MCS and within ± 5% to 50 MCS. Make no adjustments to the amplifier.

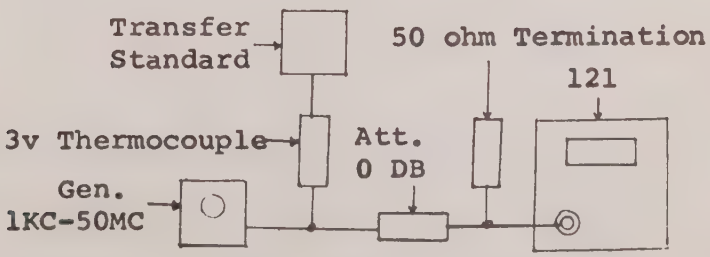
121.4423 1 v Range



Set up test equipment as shown above. After reference level at 90% of full scale has been established at 1000 cps, adjust C107 to obtain 90% of full scale at 10 MCS within $\pm$ 1/2%.

Check frequency response from 1000 cps to 10MCS to insure response within $\pm$ 1% adjusting C107 only if necessary. Check frequency response from 10 MCS to 50 MCS at 5 MC increments to insure response within $\pm$ 3% to 21 MCS and within $\pm$ 5% to 50 MCS. Make no adjustments to the amplifier.

121.4424 3 volt Range



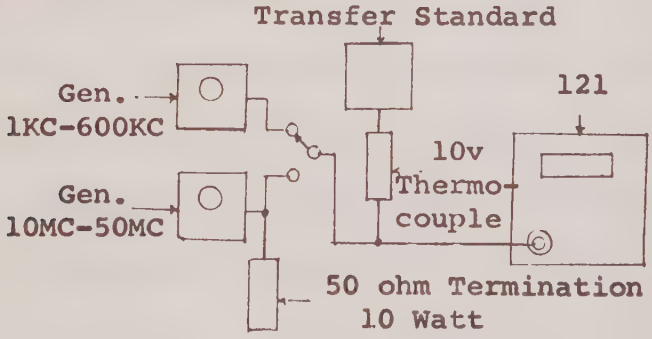
Set up equipment as shown above. After reference level at 90% of full scale has been established

121.4424 (continued)

at 1000 cps, adjust C108 to obtain 90% of full scale at 10 MCS within ± 1/2%.

Check frequency response from 1000 cps to 10 MCS to insure response within ± 1% adjusting C108 only if necessary. Check frequency response from 10 MCS to 50 MCS at 5 MC increments to insure response within ± 3% to 21 MCS and within ± 5% to 50 MCS. Make no adjustments to the amplifier

121.4425 <u>10 volt Range</u>



Set up test equipment as shown above. After reference level at 90% of full scale has been established at 1000 cps, adjust C102 to obtain 90% of full scale at 10 MCS within ± 1/2%.

Check frequency response from 1000 cps to 600 KC to insure response within ± 1%, adjust C102 only if necessary. Check frequency response from 10 MCS to 50 MCS at 5 MCS increments to insure response within

121.4425 (continued)

± 3% to 21 MCS and within ± 5% to 50 MCS. Make no adjustments to the amplifier.

121.5 Final Calibration (1 mv - 30 mv)

121.51 Gain Calibration

Connect voltmeter calibrator output of 10 mv ± .25% to the 121 input. Adjust R-121, 1K pot located on main chassis, to obtain 10 mv full scale on the 10 mv range. Insure that meter zero is correct.

121.52 Range Calibration

Check the 1 mv through 30 mv ranges on the 121 for full scale deflection ± 0.25% using the voltmeter calibrator. 1 mv range should read high because of noise. Change range resistors if necessary to obtain rated accuracy.

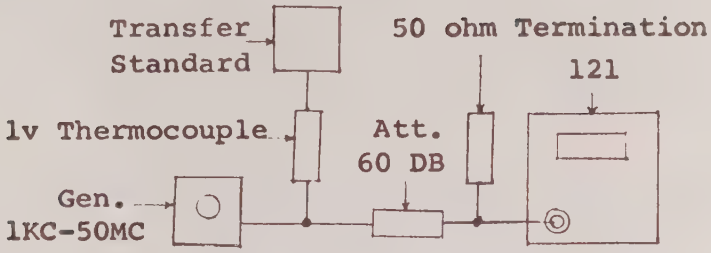
121.53 Frequency Response

121.531 Low Frequency

Switch 121 to 10 mv range. Apply 10 mv (rms) at 1000 cps using a constant amplitude function generator. Sweep to 20 cps. Adjust R302, located in front module to obtain 9 mv (rms). Sweep from 1 KC to 20 cps and check for a frequency response within ± 1%. Sweep to 15 cps. Frequency response at 15 cps should be within -5%.

121.532 High Frequency

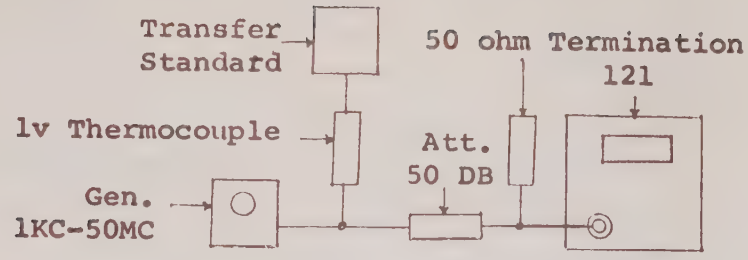
121.5321 1 mv Range



Set up test equipment as shown above. After reference level at 90% of full scale has been established at 1000 cps, sweep to 21 MCS and adjust C304 on the front amplifier to obtain a 90% of full scale reading within $\pm$ 3%. Sweep to 50 MCS and adjust C308 to obtain 90% of full scale reading within 5%. Sweep back and forth between 21 and 50 MCS adjusting C304 and C308 respectively to obtain as flat a frequency response as possible. Typical response from 21 to 50 MCS is within $\pm$ 3%, with the response at 21 MCS being within $\pm$ 1%. Note that this range has no attenuator adjustment.

Since the 1 mv - 30 mv amplifier is tuned only once (on the 1 mv range), the frequency response must be as good as possible to insure proper response on the remaining ranges.

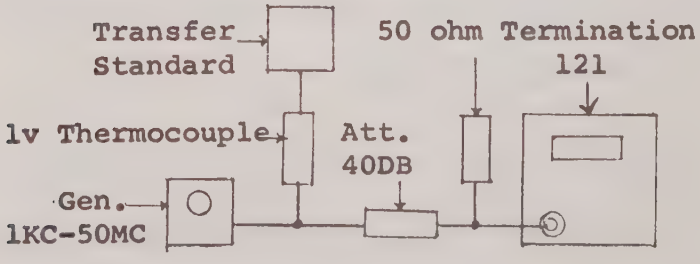
121.5322 3 mv Range



Set up test equipment as shown above. After reference level at 90% of full scale has been established at 1000 cps, adjust C118 to obtain 90% of full scale at 10 MCS within ± 1/2%.

Check frequency response from 1000 cps to 10 MCS to insure response within 1%, adjust C118 only if necessary. Check frequency response from 10 MCS to 50 MCS at 5 MC increments to insure response within ± 3% to 21 MCS and within ± 5% to 50 MCS. Make no adjustments to the amplifier.

121.5323 10 mv Range



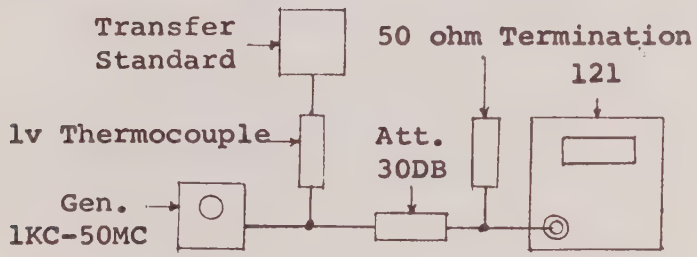
Set up test equipment as shown above. After reference level at 90% of full scale has been established at 1000 cps, adjust C119 to obtain 90% of full scale

121.5323 (continued)

at 10 MCS within ± 1/2%.

Check frequency response from 1000 cps to 10 MCS to insure response within ± 1%, adjusting C119 only if necessary. Check frequency response from 10 MCS to 50 MCS at 5 MC increments to insure response within ± 3% to 21 MCS and within ± 5% to 50 MCS. Make no adjustments to the amplifier.

121.5324 <u>30 mv Range</u>



Set up test equipment as shown above. After reference level at 90% of full scale has been established at 1000 cps, adjust C120 to obtain 90% of full scale at 10 MCS within ± 1/2%.

Check frequency response from 1000 cps to 10 MCS to insure response within ± 1% adjusting C120 only if necessary. Check frequency response from 10 MCS to 50 MCS at 5 MC increments to insure response within ± 3% to 21 MCS and within ± 5% to 50 MCS. Make no adjustments to the amplifier.

121.6 Crest Factor

Switch 121 to 30 mv range and monitor A.C. output with a scope. Apply a sufficient signal at 1000 cps to cause clipping of the input signal. The crest factor is equal to: $\frac{1.4 \times E_{1N}}{30}$

where E_{1N} is the RMS value of the input signal where clipping occurs. The crest factor should be 6 ± 10%.

121.7 Calibration Adjustments

121.71 10 v and 10 mv Calibration Signal

Switch 121 to 10 v range and apply 10 v calibration signal from 121 to the input. Adjust R-228 (20K) for full scale deflection.

Apply 10 mv calibration signal to input and switch to 10 mv range. Adjust R-229 (2K) for full scale deflection.

121.72 Probe Calibration

Plug in 1201 test probe. Apply 10 mv calibration signal to probe input and adjust R-154 (2K) for full scale deflection on the 10 mv range.

121.8 DC and AC Output

Apply 1 v (400 cps) with the 121 on the 1 v range and monitor the DC output. The output should be approximately -100 mv.

Monitor the AC output. The output should be approximately 140 mv (RMS).

121.9 Trouble-Shooting Hints

121.91 Power Supply

-12 Volts Not Regulating

a) Zener (D-110) not maintaining 9 ± .5 volts.

b) Zener (D-111) not maintaining 10 ± .5 volts.

c) Diode (D-104) open or shorted.

d) Transistor failure.

+75 Volts Not Regulating (-12 Volts OK)

a) Q7 & Q8 not switching.

b) Q9 defective.

c) Switching transformer defective.

-26 Volts Not Regulating (-12 Volts OK)

a) Q7 & Q8 not switching.

b) Q10 defective.

c) Switching transformer defective.

121.92 Amplifier

Meter Pegs Negative, Cannot Zero

a) Defective thermocouple in TRMS module.

b) Improper wiring in TRMS module.

Meter Pegs Positive, Cannot Zero

a) Improper wiring in TRMS module.

b) Open resistor.

c) Shorted capacitor.

121.93 Range Accuracy

a) Range resistors matched improperly.

121.94 Low Frequency Response Poor

121.941 100 mv - 300 v Amplifier

a) R-406 adjusted improperly.

b) C-402 improper value.

c) Q2 High Beta (should have Beta of 40 to 50).

d) V2 not by-passed properly.

121.942 1 mv - 30 mv Amplifier

a) R-302 adjusted improperly.

b) C-302 improper value.

c) Q12 High Beta (should have Beta of 40 to 50).

d) V1 not by-passed properly.

121.95 High Frequency Response Poor

121.951 10 MC Trimmer Cannot Be Adjusted Properly

a) Divider capacitor wrong value.

b) Range resistor poor frequency response.

121.952 Peaking or Dip at 100 KC - 1 MC Region

a) Divider cap out of tolerance.

b) Range resistor frequency response incorrect, causing poor crossover.

121.953 Peaking at 30-35 MCS on 100 mv Range

a) Increase C-411 which shunts feedback resistor.

121.954 Peaking of Dip at 40-50 MCS on 300 mv - 10 V Range

a) Increase or decrease R-163, R-109, R-111 or R-164, respectively.

121.96 Improper Crest Factor

a) R-416, collector load resistor for Q3, improper value.

b) -26 volts supply not proper.

121.97 Poor Drift

a) Q5 and Q6 TRMS module not matched for Beta.

b) Increase or decrease R-501 2.8K resistor.

CONDENSED

GAIN AND FREQUENCY ADJUSTMENTS

Range	Thermo-couple	Attenuation (DB)	Gain @ 400 cps	20 cps	10MC	21MC	50MC
100 mv	1 v	20	-	R-406	C-105	C-404	C-409
300 mv	1 v	10	-	-	C-106	-	-
1 v	1 v	0	R-524	-	C-107	-	-
3 v	3 v	0	-	-	C-108	-	-
10 v	10 v	0	-	-	C-102	-	-
1 mv	1 v	60	-	-	-	C-304	C-308
3 mv	1 v	50	-	-	C-118	-	-
10 mv	1 v	40	R-121	R-302	C-119	-	-
30 mv	1 v	30	-	-	C-120	-	-

SECTION 5. ACCESSORIES

5-1. GENERAL. Several available accessory probes and kits increase the usefulness of the Model 121 Voltmeter. This section describes the Model 1201 Cathode Follower Probe, the Model 1202 10:1 Divider Probe, the Model 1203 10:1 Divider Probe, Model 1204 Accessory Probe Kit and the Model 1205 Accessory Kit.

5-2. MODEL 1201 CATHODE FOLLOWER PROBE.

a. General.

1. The Model 1201 Cathode Follower Probe reduces circuit loading effects for voltages below 300 millivolts. Its frequency spectrum is from 10 cps to 50 megacycles. Input impedance is 10 megohms, 15 picofarads.

2. Besides reducing circuit loading effects, the Model 1201 allows measurements to be made more conveniently. It also protects the voltmeter from overloads up to 50 volts rms on the 1-millivolt range. Although primarily designed for Keithley voltmeters, it can be used with other instruments.

3. Principal parts of the Model 1201 are a probe body containing a 7963 vacuum tube, a detachable probe tip, a 3-foot connecting cable to the instrument input and a lead for filament power.

b. Specifications. Accuracy specifications are for Probe only. Add these to the Model 121 specifications for total accuracy.

VOLTAGE RANGE: 100 microvolts to 300 millivolts rms.

FREQUENCY RANGE: 10 cps to 50 megacycles.

1 to 30-millivolt ranges	100 and 300-millivolt ranges
±2%, 20 cps to 20 megacycles	±2%, 20 cps to 10 megacycles
±3%, 15 cps to 50 megacycles	±3%, 15 cps to 20 megacycles
	-3 db, 10 cps to 50 megacycles

INPUT IMPEDANCE: 10 megohms shunted by 15 picofarads.

TUBE COMPLEMENT: One 7963.

CONNECTOR: To Input: Teflon-insulated uhf-type plug.
To Power: Cannon XLR-5-12C plug.

c. Operating Procedures.

1. Connect the Probe uhf plug to the Model 121 INPUT Receptacle. Connect the power plug to the Model 121 PROBE Receptacle. Allow the Probe to warm up for four minutes. When disconnecting the Probe, remove the power outlet before disconnecting the plug from the INPUT.

NOTE

Always connect the probe power last, and disconnect the probe power first. The probe ground is through the uhf connector. If the power is connected without the ground, the vacuum tube in the Probe can be damaged.

2. To maintain the Probe's specified accuracy, use only the furnished cable assembly. Do not lengthen it; this increases electrostatic and magnetic pickup, and, at high frequencies, introduces inductive problems.

3. The Probe also accomodates banana plugs and alligator clips. Unscrew the probe tip and screw the new tip on the stud. A bnc-type connector is also on the Probe. An alligator clip can also be inserted over the banana plug on the ground cord assembly.

f	10 cps	100 cps	1 kc	10 kc	100 kc	1 Mc	10 Mc	50 Mc
Z	10 MΩ	9.5 MΩ	9.2 MΩ	1.04 MΩ	106 kΩ	10.6 kΩ	1.06 kΩ	210 Ω

TABLE 5-1. Approximate Input Impedance (Z) at Various Frequencies (f), for Model 1201 with Model 121.

d. Replaceable Parts. Refer to Section 6 for Model 1201 Replaceable Parts List.

5-3. MODEL 1202 10:1 DIVIDER PROBE*

a. General.

1. The Model 1202 10:1 Divider Probe is a resistive-capacitive probe with an input impedance of 10 megohms, 8 picofarads. Its frequency spectrum is from dc to 50 megacycles, and it measures potentials to 300 volts.

2. Primary use of the Probe is to increase the input impedance of the Model 121. Besides reducing circuit loading effects, the Model 1202 allows for more convenient measurements. Although primarily designed for Keithley voltmeters, it can be used with other instruments.

3. Principal parts of the Model 1202 are a probe body, a detachable probe tip and a 3-foot connecting cable.

b. Specifications.

VOLTAGE RANGE: 10 millivolts to 300 volts.
FREQUENCY RANGE: dc to 50 megacycles.

10 to 300-millivolt ranges	300-millivolt to 300-volt ranges
±5%, dc to 10 megacycles	±2%, dc to 10 megacycles
±10%, dc to 20 megacycles	±5%, dc to 30 megacycles
	±10%, dc to 50 megacycles

INPUT IMPEDANCE: 10 megohms shunted by 8 picofarads.
CONNECTOR: To Input: Teflon-insulated uhf-type plug.

*This apparatus licensed under United States Letters Patent No. 2,883,619 owned by Tektronix, Inc.

c. Operating Procedures.

1. Check the Probe adjustment (see subparagraph d). Connect the uhf-type plug on the cable assembly to the INPUT Receptacle. To maintain the Probe's specified accuracy, use only the furnished cable assembly. Do not lengthen it; this increases electrostatic and magnetic pickup, and introduces inductive problems at high frequencies.

2. Hold the Model 1202 by the aluminum body (1, fig. 6-2) behind the ground lead, as if it were a pencil. Keep your hand on the grounded body to prevent introducing sources of extraneous pickup and to prevent an increase in the input capacity of the Probe. This produces the best signal-to-noise ratio and minimizes probe loading effects on the circuit.

3. Multiply the Voltmeter reading by 10 to determine the unknown potential. Add the Probe accuracy to the Voltmeter accuracy to obtain total accuracy.

4. The Probe also accomodates banana plugs and alligator clips. Unscrew the probe tip (7, fig. 6-2) and screw the new tip on the stud (6, fig. 6-2). An alligator clip can also be inserted over the banana plug on the ground cord assembly.

f	1 cps	10 cps	100 cps	1 kc	10 kc	100 kc	1 Mc	10 Mc	50 Mc
Z	10 MΩ	10 MΩ	9.5 MΩ	6.7 MΩ	1.7 MΩ	190 kΩ	20 kΩ	2 kΩ	400 Ω

TABLE 5-2. Approximate Input Impedance (Z) at Various Frequencies (f) for Model 1202 with Model 121.

d. Adjustments.

1. The dc voltage ratio of the divider is fixed by the 9-megohm resistor in the Probe and the 1-megohm input resistance of the Model 121. The high-frequency ratio is set with an adjustable capacity divider.

2. Check the 10:1 ratio by measuring a known reference, ±0.5%, at approximately 1 volt and at 350 kc or higher. To adjust the Model 1202, loosen the locking ring (3, fig. 6-2) and turn the capacitor adjusting screw (4, fig. 6-2). Tighten the locking ring by hand after the proper ratio is reached.

e. Replaceable Parts. Refer to Section 6 for the Model 1202 Replaceable Parts List.

5-4. MODEL 1203 10:1 DIVIDER PROBE*

a. General.

1. The Model 1203 10:1 Divider Probe is a capacitive probe with an input capacity of five picofarads. It does not respond to dc; its frequency spectrum is from 20 kc to 50 megacycles. The Probe measures potentials to 300 volts.

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2. Primary use of the Probe is to increase the input impedance of the Model 121. Its 60-cps rejection is approximately 30 db. Although designed primarily for Keithley voltmeters, it can be used with other instruments.

3. Principal parts of the Model 1203 are a probe housing, a detachable probe tip and a 3-foot removable connecting cable.

b. Specifications.

VOLTAGE RANGE: 10 millivolts to 300 volts.
FREQUENCY RANGE: 20 kc to 50 megacycles.

10 to 300-millivolt ranges	300-millivolt to 300-volt ranges
±5%, 50 kc to 10 megacycles	±2%, 50 kc to 10 megacycles
±10%, 30 kc to 20 megacycles	±5%, 30 kc to 30 megacycles
	±10%, 20 kc to 50 megacycles

INPUT IMPEDANCE: 5 picofarads.
CONNECTOR: To Input: Teflon-insulated uhf-type plug.

c. Operating Procedures.

1. Note the frequency spectrums of the Voltmeter and the Probe; the Model 1203 has a narrower response.

2. Check the Probe adjustment (see subparagraph d). Adjust the Probe everytime the voltmeter range is changed. This is necessary because the input capacity may change slightly between ranges. For instance, a 1-picofarad change in the voltmeter input capacity can introduce a division ratio inaccuracy of 2% — the Probe's specified accuracy — although the Probe input capacity will be changed by only about 0.1 picofarad.

3. Connect the uhf-type plug on the cable assembly to the INPUT Receptacle. To maintain the Probe's specified accuracy, use only the furnished cable assembly. Do not lengthen it; this increases electrostatic and magnetic pickup, and introduces inductive problems at high frequencies.

4. Hold the Model 1203 by the connector (9, fig. 6-3) behind the ground lead. This prevents the introduction of sources of extraneous pickup and prevents an increase in the probe input capacity. This produces the best signal-to-noise ratio and minimizes probe loading effects on the circuit. The Probe is easy to handle in this way because it is small and lightweight.

5. Multiply the voltmeter readings by 10 to determine the potential of the source. Add the Probe accuracy to the Voltmeter accuracy to obtain the total accuracy.

6. The Probe also accommodates banana plugs and alligator clips. Unscrew the probe tip (7, fig. 6-3) and screw the new tip on the stud (6, fig. 6-3) An alligator clip can also be inserted over the banana plug on the ground cord assembly.

f	50 kc	100 kc	1 Mc	10 Mc	50 Mc
Z	620 kΩ	310 kΩ	31 kΩ	3.1 kΩ	620 Ω

TABLE 5-3. Approximate Input Impedance (Z) at Various Frequencies (f) for Model 1203 with Model 121.

d. Adjustments.

1. Check the 10:1 ratio by measuring a known reference, ±0.5%, at 350 kc or higher. Use a source which will indicate at least half-scale on the voltmeter. To adjust the Model 1203, loosen the locking ring (3, fig. 6-3) and rotate the probe housing (1, fig. 6-3) while the probe tip is connected to the known signal. Tighten the locking ring by hand after the proper ratio is reached.

2. It may be necessary to set the meter indication slightly high, since tightening may lower the meter indication. Also, keep your hands behind the probe ground lead before checking the accuracy.

e. Replaceable Parts. Refer to Section 6 for Model 1203 Replaceable Parts List.

5-5. MODEL 1204 ACCESSORY PROBE KIT. (See Fig. 5-1.) The Model 1204 Accessory Probe Kit contains the Model 1202 and the Model 1203 Probes and two extra interchangeable tips for each Probe: an alligator clip and a banana plug. The entire kit is packaged in a case 2 inches high x 12 inches wide x 8 inches deep with polyethelene-foam compartments. It weighs approximately three pounds.

FIGURE 5-1. Model 1204 Accessory Probe Kit.

-6. MODEL 1205 ACCESSORY KIT.

a. The Model 1205 Accessory Kit provides three adapters, two cables, a filter and a termination for all Keithley Wideband Voltmeters. The kit case is 2 inches high x 12 inches wide x 8 inches deep with polyethelene-foam compartments. It weighs approximately three pounds.

b. The low-pass filter has a response from 10 cps to 1 megacycle when terminated into one megohm, 20 picofarads. It is used on the Model 121 INPUT Receptacle.

Item, Fig. 5-2	Description	Keithley Part No.
1	Cable Assembly (includes two uhf plugs, CS-49, which mate with CS-64)	15084B
2	Adapter, male uhf to General Radio Type 874	CS-113
3	50-ohm Termination, male uhf to female uhf	CS-122
4	Adapter, male uhf to female bnc	CS-115
5	Low-pass filter, male uhf to female uhf	CS-123
6	Adapter, female uhf to General Radio Type 874	CS-112
7	Test Lead Assembly (includes one uhf plug, CS-49, which mates with CS-64, and two alligator clips, AC-8)	15083B

TABLE 5-4. Contents of Model 1205 Accessory Kit.

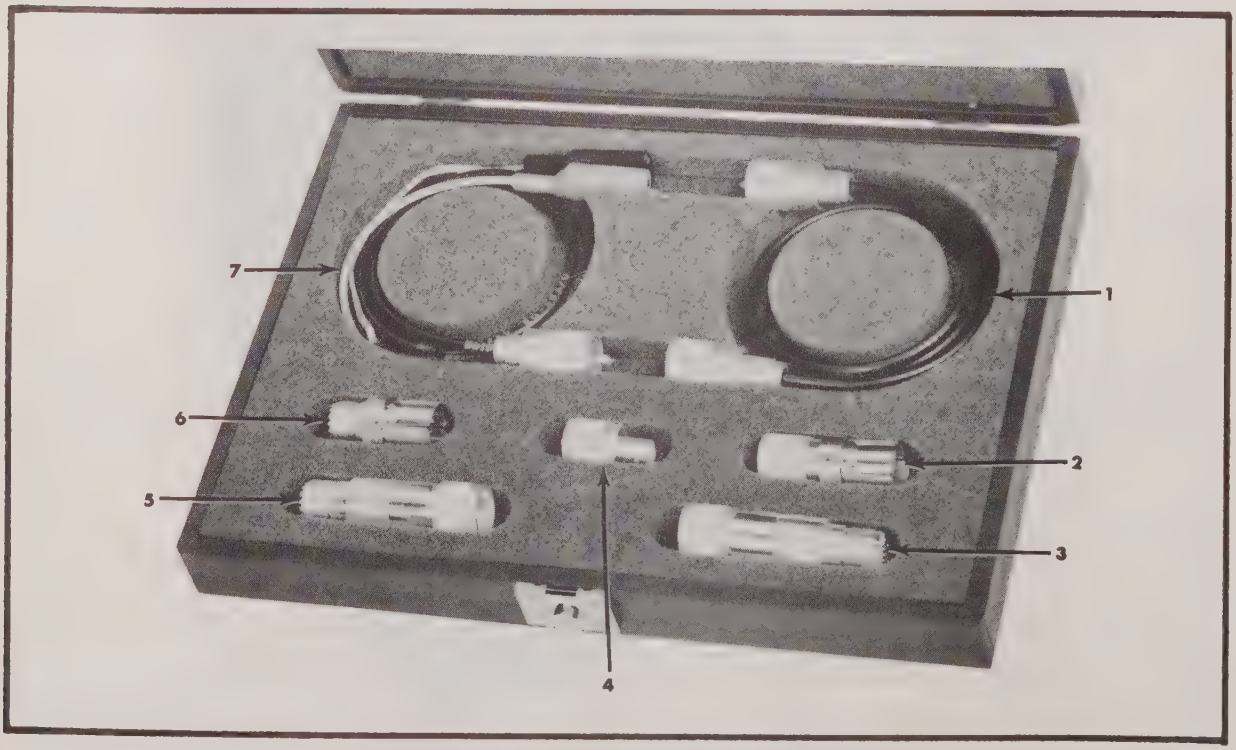


FIGURE 5-2. Model 1205 Accessory Kit.

SECTION 6. REPLACEABLE PARTS

6-1. REPLACEABLE PARTS LIST. The Replaceable Parts List describes the components of the Model 121 and its accessories. The List gives the circuit designation, the part description, a suggested manufacturer, the manufacturer's part number and the Keithley Part Number. The last column indicates the figure picturing the part. The name and address of the manufacturers listed in the "Mfg. Code" column are contained in Table 6-2.

6-2. HOW TO ORDER PARTS.

a. For parts orders, include the instrument's model and serial number, the Keithley Part Number, the circuit designation and a description of the part. All structural parts and those parts coded for Keithley manufacture (80164) must be ordered from Keithley Instruments, Inc. In ordering a part not listed in the Replaceable Parts List, completely describe the part, its function and its location.

b. Order parts through your nearest Keithley representative or Sales Service Department, Keithley Instruments, Inc.

amp	ampere	M or meg	mega (10^6) or megohms
		m	milli (10^{-3})
CbF	Carbon Film	Mfg.	Manufacturer
CbVar	Carbon Variable	Mil. No.	Military Type Number
CerD	Ceramic, Disc	MtF	Metal Film
CerS	Ceramic, Standoff	My	Mylar
CerT	Ceramic, Tubular		
Comp	Composition	Ω	ohm
CompV	Composition Variable		
		p	pico (10^{-12})
DCb	Deposited Carbon		
		SO	Stand-off
EMC	Electrolytic, Metal Cased		
ETB	Electrolytic, Tubular	μ	micro (10^{-6})
ETT	Electrolytic, Tantalum		
		v	volt
f	farad	Var	Variable
FT	Feed Through		
		w	watt
hy	Henry	WW	Wirewound
		WWVar	Wirewound Variable
k	kilo (10^3)		

TABLE 6-1. Abbreviations and Symbols.

MODEL 121 REPLACEABLE PARTS LIST
(Refer to 15760E for circuit designations)

CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
C101	0.1 μf	400 v	My	13050	MW1A	C86-0.1M
C102	4.5/25 pf	500 v	Trimmer	71590	822AZ	C76-4.5/25P
C103	3.3 pf	600 v	CerT	72982	301C0J339C	C132-3.3P
C104	2.2 pf	600 v	CerT	72982	301C0J229C	C132-2.2P
C105	1.5/7 pf	500 v	Trimmer	71590	822 EZ	C76-1.5/7P
C106	3/12 pf	500 v	Trimmer	71590	822 FZ	C76-3/12P
C107	4.5/25 pf	500 v	Trimmer	71590	822 AZ	C76-4.5/25P
C108	4.5/25 pf	500 v	Trimmer	71590	822 AZ	C76-4.5/25P
C109	470 pf	1000 v	CerD	72982	831Z5V471P	C22-470P
C110	6.8 μf	35 v	ETT	05397	K6R8J35KS	C81-6.8M
C111	0.02 μf	1000 v	CerD	72982	841Z5V203P	C22-.02M
C112	0.02 μf	1000 v	CerD	72982	841Z5V203P	C22-.02M
C113	0.02 μf	1000 v	CerD	72982	841Z5V203P	C22-.02M
C114	470 pf	350 v	SO	00656	DS-C	C16-470P
C115	0.02 μf	1000 v	CerD	72982	841Z5V203P	C22-.02M
C116	100 μf	10 v	ETT	05397	K100J10S	C78-100M
C117	100 μf	10 v	ETT	05397	K100J10S	C78-100M
C118	3/12 pf	500 v	Trimmer	71590	822FZ	C76-3/12P
C119	3/12 pf	500 v	Trimmer	71590	822FZ	C76-3/12P
C120	1.5/3 pf	500 v	Trimmer	71590	822DZ	C76-1.5/3P
C121	15 pf	600 v	CerT	71590	TCZ	C77-15P
C122	39 pf	600 v	CerT	71590	TCZ	C77-39P
C123	47 pf	600 v	CerT	71590	TCZ	C77-47P
C124	470 pf	1000 v	CerD	72982	831Z5V471P	C22-470P
C125	6.8 μf	35 v	ETT	05397	K6R8J35KS	C81-6.8M
C126	0.02 μf	1000 v	CerD	72982	841Z5V203P	C22-.02M
C127	0.02 μf	1000 v	CerD	72982	841Z5V203P	C22-.02M
C128	0.02 μf	1000 v	CerD	72982	841Z5V203P	C22-.02M
C129	0.02 μf	1000 v	CerD	72982	841Z5V203P	C22-.02M
C130	470 pf	350 v	SO	00656	DS-C	C16-470P
C131	Not Used					
C132	Not Used					
C133	0.02 μf	1000 v	CerD	72982	841Z5V203P	C22-.02M
C134	68 μf	20 v	ETT	05397	K68J20K	C81-68M
C135	0.47 μf	1000 v	CerD	72982	811Z5V472M	C22-.47M
C136	4.7 pf	600 v	CerT	71590	TCZ	C77-4.7P
C137	5 pf	1000 v	CerD	72982	831U2M509B	C22-5P
C138	75 pf	600 v	CerT	71590	TCZ	C77-75P

CAPACITORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
C139	100 µf	10 v	ETT	05397	K100J10S	C78-100M
C140	470 pf	350 v	SO	00656	DS-C	C16-470P
C141	Not Used					
C142	1000 µf	15 v	ETB	72699	TD1000-15	C11-1000M
C143	6.8 pF	600 v	CerT	71590	TCZ	C77-6.8P
C144	Not Used					
C145	100 µf	50 v	ETT	37942	TC3501	C39-100M
C146	100 µf	15 v	ETT	05397	K100J15K	C79-100M
C147	6 µf	100 v	ETB	56289	TE1405	C60-6M
C148	100 µf	15 v	ETT	05397	K100J15K	C79-100M
C149	20 µf	100 v	ETB	56289	TE1409	C60-20M
C150	100 µf	15 v	ETT	05397	K100J15K	C79-100M
C151	Not Used					
C152	30 pf	600 v	CerT	71590	TCZ	C77-30P
C153	0.75 pf	600 v	CerT	72982	301C0K758C	C132-.75P
C154	47 pf	600 v	CerT	71590	TCZ	C77-47P
C155	0.3 pf	500 v	CerT	00656	CN	C132-0.3P
C156	10 pf	600 v	CerT	71590	TCZ	C77-10P
C201	40 µf	350 v	EMC	53021	505-1022-01	C19-40M
C202	500/500 µf	35/35 v	EMC	53021	505-2603-01	C20-500/500M
C203	500/500 µf	35/35 v	EMC	53021	505-2603-01	C20-500/500M
C204	100 pf	1000 v	CerD	72982	831X5R101K	C22-100P
C205	1.2 µf	20 v	ETT	05397	K1R2J20K	C80-1.2M
C206	1000 µf	12 v	EMC	56289	DFP	C24-1000M
C207	100 µf	25 v	ETT	05079	W100-25C2U1	C96-100M
C208	40/80 µf	80/80 v	EMC	80164		C25-40/80M
C209	500/500 µf	35/35 v	EMC	53021	505-2603-01	C20-500/500M
C210	500/500 µf	35/35 v	EMC	53021	505-2603-01	C20-500/500M
C211	40/80 µf	80/80 v	EMC	80164		C25-40/80M
C212	150 µf	80 v	EMC	80164		C26-150M
C213	500 µf	25 v	EMC	80164		C40-500M
C214	1.0 µf	25 v	CerD	56289	5C13	C85-1.0M
C215	1 µf	200 v	My	13050	107-21	C66-1M
C216	470 pf	1000 v	CerD	72982	831Z5V471P	C22-470P
C217	470 pf	1000 v	CerD	72982	831Z5V471P	C22-470P
C218	470 pf	1000 v	CerD	72982	831Z5V471P	C22-470P
C219	470 pf	1000 v	CerD	72982	831Z5V471P	C22-470P
C220	.001 µf	1000 v	CerD	72982	801Z5V102P	C22-.001M
C221	1 µf	25 v	CerD	56289	5C13	C85-1M
C222	.22 µf	50 v	My	84411	601PE	C41-.22M
C223	.22 µf	50 v	My	84411	601PE	C41-.22M
C224	20 µf	100 v	ETB	56289	TE1409	C60-20M

CONNECTORS

Circuit Desig.	Description	Mfg. Code	Keithley Part No.
J-1	Receptacle, uhf, INPUT, Mil. No. SO-239 (Mfg. No. 6804)	91737	CS-64
---	See P-1 for mate		
---	Binding Post, G, Front panel (Mfg. No. 33-286)	08811	BP-15
J-2	Banana Jack, 10 V CAL SIGNAL (Mfg. No. 108-902)	74970	BJ-6R
J-3	Banana Jack, 10 MV CAL SIGNAL (Mfg. No. 108-902)	74970	BJ-6R
J-4	Banana Jack, GND CAL SIGNAL (Mfg. No. 108-903)	74970	BJ-6B
J-5	Receptacle, uhf, AC OUTPUT, Mil. No. SO-239 (Mfg. No. 6804)	91737	CS-64
---	Binding Post, G, Rear panel (Mfg. No. 33-286)	08811	BP-15
J-6	Binding Post, Red, DC OUTPUT (Mfg. No. DF21RC)	58474	BP-11R
J-7	Binding Post, Black, DC OUTPUT (Mfg. No. DF21BC)	58474	BP-11B
J-8	Receptacle, PROBE (Mfg. No. XLR-5-31)	71468	CS-3
---	Plug, Mate of J-8 (Mfg. No. XLR-5-12C)	71468	CS-4

DIODES

Circuit Desig.	Type	Number	Mfg. Code	Keithley Part No.
D101	Silicon	1N3252	02735	RF-17
D102	Silicon	1N1563A	04713	RF-19
D103	Silicon	1N1563A	04713	RF-19
D104	Silicon	1N645	01295	RF-14
D105	Not Used			
D106	Silicon	1N3252	02735	RF-17
D107	Silicon	1N3252	02735	RF-17
D108	Silicon	1N3253	02735	RF-20
D109	Silicon	1N3253	02735	RF-20
D110	Zener	1N936	04713	DZ-5
D111	Zener	1N715	12954	DZ-22

MISCELLANEOUS PARTS

Circuit Desig.	Description	Mfg. Code	Keithley Part No.
---	Pilot Light Assembly (Mfg. No. 81410-212)	72619	PL-5G
DS-1	Bulb, Lamp (Mfg. No. 47)	08804	PL-4
E-1	Chopper Assembly, See page 6-11, E-1		

MISCELLANEOUS PARTS (Cont'd)

Circuit Desig.	Description	Mfg. Code	Keithley Part No.
---	Fuse Holder (Mfg. No. 342012)	75915	FH-3
F1 (117v)	Fuse, Slow blow, 0.75 amp (Mfg. Type MDL)	71400	FU-19
F1 (234v)	Fuse, Slow blow, 0.38 amp (Mfg. Type MDL)	71400	FU-18
L1	Choke, 1 μhy	80164	CH-2
15696C	Three-stage AC Amplifier, See pg. 6-10 for parts list.	80164	15695B
15759D	TRMS Module, See pg. 6-11 for parts list.	80164	15883B
16028C	Three-stage AC Amplifier, See pg. 6-8 for parts list.	80164	16025B
M-1	Meter (Weston)	80164	ME-25
	** Meter (Simpson)	80164	ME-61
	** Meter (Rowan)	80164	ME-58
P-1	Power Cord, 6 feet (Mfg. No. 4638-13)	82879	CO-2
---	Cable Clamp (Mfg. No. SR-6P-1)	28520	CC-7
P2	Plug, uhf, Mate of J1 and J5, Mil. No. 49190 (Mfg. No. 83-822)	02660	CS-49
S1	Rotary Switch, less components, Range	80164	SW-136
---	(Switch sub-assembly with shields)	80164	15030B
---	Knob Assembly, Range Switch	80164	15017A
S-2	Toggle Switch, SPST, ON	80164	SW-4
---	Knob Assembly, Zero Potentiometer	80164	15110A
T1	Transformer, Power Supply	80164	TR-59
T2	Transformer, Switching	80164	TR-22

RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R101	990 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-990K
R102	10.1 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-10.1K
R103	850 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-850K
R104	952.6 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-952.6K
R105	985.0 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-985.0K
R106	995.3 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-995.3K
R107	150 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-150K
R108	47.44 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-47.44K
R109	*15 Ω	5%, 1/2 w	Comp	01121	EB	R19-15
R110	15 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-15K

* Nominal value, factory set.

** Alternate meters used in some instruments instead of ME-25. There is no difference in performance.

RESISTORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R111	*15 Ω	5%, 1/2 w	Comp	01121	EB	R19-15
R112	4.722 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-4.722K
R113	1 MΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-1M
R114	220 Ω	10%, 1/4 w	Comp	44655	RC07	R76-220
R115	1.2 kΩ	10%, 1/4 w	Comp	01121	CB	R76-1.2K
R116	10 Ω	10%, 1/4 w	Comp	44655	RC07	R76-10
R117	1.5 kΩ	10%, 1/2 w	Comp	01121	EB	R1-1.5K
R118	100 Ω	10%, 1/4 w	Comp	01121	CB	R76-100
R119	10 Ω	10%, 1/4 w	Comp	44655	RC07	R76-10
R120	300 Ω	0.5%, 1/4 w	MtF	07716	CEB	R75-300
R121	1 kΩ	20%, .2 w	CompV	71450	70	RP31-1K
R122	1 kΩ	0.5%, 1/4 w	MtF	07716	CEB	R75-1K
R123	6.838 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-6.838K
R124	9.000 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-9.000K
R125	9.684 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-9.684K
R126	10 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-10K
R127	3.162 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-3.162K
R128	1 kΩ	0.5%, 1/2 w	MtF	07716	CEC	R61-1K
R129	316.2 Ω	0.5%, 1/2 w	MtF	07716	CEC	R61-316.2
R130	Not Used					
R131	100 Ω	10%, 1/4 w	Comp	01121	CB	R76-100
R132	10 Ω	10%, 1/4 w	Comp	44655	RC07	R76-10
R133	3.3 kΩ	10%, 1/2 w	Comp	01121	EB	R1-3.3K
R134	100 Ω	10%, 1/2 w	Comp	01121	CB	R76-100
R135	10 Ω	10%, 1/4 w	Comp	44655	RC07	R76-10
R136	Not Used					
R137	Not Used					
R138	Not Used					
R139	1 kΩ	10%, 1/4 w	Comp	01121	CB	R76-1K
R140	330 kΩ	10%, 1/4 w	Comp	01121	CB	R76-330K
R141	47 Ω	10%, 1/4 w	Comp	44655	RC07	R76-47
R142	330 kΩ	10%, 1/4 w	Comp	01121	CB	R76-330K
R143	Not Used					
R144	1 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-1K
R145	10 Ω	10%, 1/4 w	Comp	44655	RC07	R76-10
R146	3.3 kΩ	10%, 1/2 w	Comp	01121	EB	R1-3.3K
R147	100 Ω	10%, 1/4 w	Comp	01121	CB	R76-100
R148	18 kΩ	3%, 2 w	WW	02985	TS-2W	R83-18K
R149	200 Ω	10%, 5 w	WWVar	71450	AW	RP3A-200
R150	10 kΩ	10%, 2 w	WWVar	71450	252	RP37A-10K

* Nominal value, factory set.

RESISTORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R151	100 Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-100
R152	500 Ω	3%, 1 w	WW	02985	TS-1W	R81-500
R153	Not Used					
R154	2 kΩ	10%, 5 w	WWVar	71450	AW	RP3A-2K
R155	10 Ω	10%, 1/4 w	Comp	44655	RC07	R76-10
R156	Not Used					
R157	47 Ω	10%, 1/4 w	Comp	44655	RC07	R76-47
R158	Not Used					
R159	Not Used					
R160	10 Ω	10%, 1/4 w	Comp	44655	RC07	R76-10
R161	10 Ω	10%, 1/4 w	Comp	44655	AB	R76-10
R162	7 kΩ	1%, 5 w	WW	91637	RS-5	R4A-7K
R163	*22 Ω	5%, 1/2 w	Comp	01121	EB	R19-22
R164	*47 Ω	5%, 1/2 w	Comp	01121	EB	R19-47
R165	47 Ω	10%, 1/4 w	Comp	44655	RC07	R76-47
R201	27 kΩ	10%, 1 w	Comp	01121	GB	R2-27K
R202	0.5 Ω	10%, 10 w	WW	44655	1700A	R66-0.5
R203	560 Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-560
R204	10 kΩ	10%, 1/2 w	Comp	01121	EB	R1-10K
R205	10 kΩ	10%, 1/2 w	Comp	01121	EB	R1-10K
R206	300 Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-300
R207	10 kΩ	10%, 1/2 w	Comp	01121	EB	R1-10K
R208	4.7 kΩ	10%, 1/2 w	Comp	01121	EB	R1-4.7K
R209	225 Ω	10%, 5 w	WW	56289	57E	R96-225
R210	600 Ω	3%, 1 w	WW	02985	TS-1W	R81-600
R211	Not Used					
R212	27 Ω	10%, 1/2 w	Comp	01121	EB	R1-27
R213	47 Ω	10%, 1/2 w	Comp	01121	EB	R1-47
R214	10 Ω	10%, 1/2 w	Comp	01121	EB	R1-10
R215	25 Ω	1%, 5 w	WW	91637	RS-5	R4A-25
R216	1.5 kΩ	10%, 1/2 w	Comp	01121	EB	R1-1.5K
R217	22 kΩ	10%, 1/2 w	Comp	01121	EB	R1-22K
R218	47 Ω	10%, 2 w	Comp	01121	HB	R3-47
R219	1.8 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-1.8K
R220	10 kΩ	10%, 1/2 w	Comp	01121	EB	R1-10K
R221	1 Ω	1%, 5 w	WW	91637	RS-5	R4A-1
R222	20 Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-20
R223	19.5 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-19.5K
R224	30 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-30K
R225	200 Ω	3%, 1 w	WW	02985	TS-1W	R81-200

* Nominal value, factory set.

RESISTORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R226	15 Ω	1%, 5 w	WW	91637	RS-5	R4A-15
R227	2.2 kΩ	10%, 1/2 w	Comp	01121	EB	R1-2.2K
R228	20 kΩ	20%, .2 w	CompV	71450	70	RP31-20K
R229	2 kΩ	20%, .2 w	CompV	71450	70	RP31-2K
R230	1 kΩ	10%, 1/2 w	Comp	01121	EB	R1-1K
R231	200 Ω	10%, 5 w	WWVar	71450	AW	RP3A-200

TRANSISTORS

Circuit Desig.	Number	Mfg. Code	Keithley Part No.
Q1	2N1535	04713	TG-7
Q2	2N1183	02735	TG-11
Q3	2N1381	01295	TG-8
Q4	2N1381	01295	TG-8
Q5	2N1381	01295	TG-8
Q6	2N1381	01295	TG-8
Q7	2N1183	02735	TG-11
Q8	2N1183	02735	TG-11
Q9	2N1183	02735	TG-11
Q10	2N1183	02735	TG-11

VACUUM TUBES

Circuit Desig.	Number	Mfg. Code	Keithley Part No.
V1	7586	86684	EV-7586
V2	7586	86684	EV-7586
V3	7586	86684	EV-7586

ASSEMBLY 16025B REPLACEABLE PARTS LIST
(Refer to 16028C for circuit designations)

CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
C301	33 μf	10 v	ETT	05397	K33J10S	C78-33M
C302	2.2 μf	20 v	ETT	05397	K2R2J20K	C80-2.2M
C303	100 μf	10 v	ETT	05397	K100J10S	C78-100M
C304	1.5/7 pf	500 v	Trimmer	71590	822EZ	C76-1.5/7P
C305	68 μf	15 v	ETT	05397	K68J15KS	C79-68M
C306	100 μf	10 v	ETT	05397	K100J10S	C78-100M
C307	100 μf	10 v	ETT	05397	K100J10S	C78-100M

CAPACITORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
C308	4.5/25 pf	500 v	Trimmer	71590	822AZ	C76-4.5/25P
C309	6.8 pf	600 v	CerT	71590	TCZ	C77-6.8P
C310	15 pf	600 v	CerT	71590	TCZ	C77-15P
C311	10 pf	600 v	CerT	71590	TCZ	C77-10P
C312	.22 μf	50 v	My	84411	601PE	C41-.22M

RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R301	470 Ω	10%, 1/4 w	Comp	01121	CB	R76-470
R302	50 kΩ	20%, .2 w	CbVar	80294	3068S	RP40-50K
R303	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K
R304	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K
R305	75 Ω	0.5%, 1/4 w	MtF	07716	CEB	R75-75
R306	22 kΩ	10%, 1/4 w	Comp	01121	CB	R76-22K
R307	68 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-68K
R308	47 kΩ	10%, 1/4 w	Comp	01121	CB	R76-47K
R309	470 Ω	10%, 1/4 w	Comp	01121	CB	R76-470
R310	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K
R311	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K
R312	1 kΩ	0.5%, 1/4 w	MtF	07716	CEB	R75-1K
R313	68 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-68K
R314	600 Ω	0.5%, 1/4 w	MtF	07716	CEC	R61-600
R315	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K
R316	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K
R317	100 Ω	0.5%, 1/4 w	MtF	07716	CEB	R75-100
R318	3.3 kΩ	10%, 1/4 w	Comp	01121	CB	R76-3.3K
R319	3.3 kΩ	10%, 1/4 w	Comp	01121	CB	R76-3.3K

TRANSISTORS

Circuit Desig.	Number	Mfg. Code	Keithley Part No.
Q1 to Q10	Not Used		
Q11	1294	04713	TG-18
Q12	1294	04713	TG-18
Q13	SM492	04713	TG-17

ASSEMBLY 15695B REPLACEABLE PARTS LIST
(Refer to 15696C for circuit designations)

CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
C401	33 µf	10 v	ETT	05397	K33J10S	C78-33M
C402	2.2 µf	20 v	ETT	05397	K2R2J20K	C80-2.2M
C403	100 µf	10 v	ETT	05397	K100J10S	C78-100M
C404	1.5/7 pf	500 v	Trimmer	71590	822EZ	C76-1.5/7P
C405	68 µf	15 v	ETT	05397	K68J15KS	C79-68M
C406	100 µf	10 v	ETT	05397	K100J10S	C78-100M
C407	10 pf	600 v	CerT	71590	TCZ	C77-10P
C408	100 µf	10 v	ETT	05397	K100J10S	C78-100M
C409	4.5/25 pf	500 v	Trimmer	71590	822AZ	C76-4.5/25P
C410	2.2 pf	600 v	CerT	72982	301C0J229C	C132-2.2P
C411	*2.7 pf	500 v	CerT	00656	CN	C132-2.7P

RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R401	470 Ω	10%, 1/4 w	Comp	01121	CB	R76-470
R402	3.3 kΩ	10%, 1/4 w	Comp	01121	CB	R76-3.3K
R403	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K
R404	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K
R405	68 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-68K
R406	50 kΩ	20%, .2 w	CbVar	80294	3068S	RP40-50K
R407	3.3 kΩ	10%, 1/4 w	Comp	01121	CB	R76-3.3K
R408	100 Ω	0.5%, 1/4 w	MtF	07716	CEB	R75-100
R409	560 Ω	10%, 1/4 w	Comp	01121	CB	R76-560
R410	47 kΩ	10%, 1/4 w	Comp	01121	CB	R76-47K
R411	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K
R412	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K
R413	470 Ω	10%, 1/4 w	Comp	01121	CB	R76-470
R414	1 kΩ	0.5%, 1/4 w	MtF	07716	CEB	R75-1K
R415	100 kΩ	10%, 1/4 w	Comp	01121	CB	R76-100K
R416	698 Ω	1%, 1/8 w	CbF	01295	CG1/8	R79-698
R417	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K
R418	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K
R419	83 Ω	0.5%, 1/4 w	MtF	07716	CEB	R75-83
R420	3.3 kΩ	10%, 1/4 w	Comp	01121	CB	R76-3.3K

* Nominal value, factory set.

TRANSISTORS

Circuit Desig.	Number	Mfg. Code	Keithley Part No.
Q1	1294	04713	TG-18
Q2	1294	04713	TG-18
Q3	1294	04713	TG-18

ASSEMBLY 15883B REPLACEABLE PARTS LIST
(Refer to 15759D for circuit designations)

CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
C501	33 μf	10 v	ETT	05397	K33J10S	C78-33M
C502	33 μf	35 v	ETT	05397	K33J35K	C81-33M
C503	33 μf	10 v	ETT	05397	K33J10S	C78-33M
C504	33 μf	10 v	ETT	05397	K33J10S	C78-33M
C505	33 μf	35 v	ETT	05397	K33J35K	C81-33M
C506	33 μf	35 v	ETT	05397	K33J35K	C81-33M
C507	22 μf	35 v	ETT	05397	K22J35K	C81-22M
C508	100 μf	10 v	ETT	05397	K100J10S	C78-100M
C509	.01 μf	1000 v	CerD	72982	811Z5V103P	C22-.01M
C510	.01 μf	1000 v	CerD	72982	811Z5V103P	C22-.01M
C511	100 μf	10 v	ETT	05397	K100J10S	C78-100M

MISCELLANEOUS PARTS

Circuit Desig.	Description	Mfg. Code	Keithley Part No.
D501	Zener Diode, No. 1N936	04713	DZ-5
D502	Silicon Diode, No. 1N914	01295	RF-28
---	Chopper Assembly	80164	15898B
E-1	Chopper	80164	CV-5
---	Thermocouple Matched Assembly	80164	15891A
TC1	**Thermocouple	---	TM-1
TC2	**Thermocouple	---	TM-1

RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R501	2.8 kΩ	1%, 1 w	WW	02985	TS-1W	R82-2.8K
R502	20 Ω	1%, 1 w	WW	01686	7009	R104-20

** Order TC1 or TC2 as matched pair, part 15891A.

RESISTORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R503	1 kΩ	.1%, 1/4 w	WW	01686	7009	R95-1K
R504	1 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-1K
R505	1 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-1K
R506	1 kΩ	.1%, 1/4 w	WW	01686	7009	R95-1K
R507	35 kΩ	3%, 2 w	WW	02985	TS-2W	R83-35K
R508	6 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-6K
R509	6 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-6K
R510	10 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-10K
R511	10 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-10K
R512	15 kΩ	3%, 1 w	WW	02985	TS-1W	R81-15K
R513	2.2 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-2.2K
R514	2.2 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-2.2K
R515	2.2 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-2.2K
R516	2.2 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-2.2K
R517	20 kΩ	3%, 1 w	WW	02985	TS-1W	R81-20K
R518	3 kΩ	1%, 1 w	WW	02985	TS-1W	R82-3K
R519	8 kΩ	3%, 2 w	WW	02985	TS-2W	R83-8K
R520	15 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-15K
R521	4 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-4K
R522	8 kΩ	3%, 2 w	WW	02985	TS-2W	R83-8K
R523	1 kΩ	3%, 1 w	WW	02985	TS-1W	R81-1K
R524	1 kΩ	10%, 1/2 w	WWVar	80294	3067S	RP35-1K
R525	18 kΩ	10%, 1/4 w	Comp	01121	CB	R76-18K
R526	*2.2 kΩ	10%, 1/4 w	Comp	01121	CB	R76-2.2K
R527	560 Ω	10%, 1/4 w	Comp	01121	CB	R76-560

TRANSISTORS

Circuit Desig.	Number	Mfg. Code	Keithley Part No.
Q1	2N651	04713	TG-9
Q2	2N651	04713	TG-9
Q3	2N651	04713	TG-9
Q4	2N651	04713	TG-9
Q5	2N651	04713	TG-9
Q6	2N651	04713	TG-9

* Nominal value, factory set.

MODEL 1201 REPLACEABLE PARTS LIST
(Refer to 15483C for circuit designations)

CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
C101	.01 μf	300 v	CerT	01884	MPX103K3	C61-.01M
C102	7/25 pf	350 v	Trimmer	72982	538-011-93R	C89-7/25P
C103	.01 μf	25 v	CerT	93958	T01R	C90-.01M
C104	.01 μf	150 v	CerS	71590	DM103	C91-.01M

MISCELLANEOUS PARTS

Circuit Desig.	Description	Mfg. Code	Keithley Part No.
J101	Receptacle, bnc, Input, Mil. No. UG-1094/U (Mfg. No. 31-221)	02660	CS-15
J102	Plug, uhf, Output, Mil. No. 49190 (Mfg. No. 83-822)	02660	CS-49
J103	Plug, Power (Mfg. No. XLR-5-12C)	71468	CS-4
V101	Vacuum Tube, No. 7963	00011	EV-7963

RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R101	47 Ω	10%, 1/4 w	Comp	44655	AB	R76-47
R102	22 MΩ	10%, 1/4 w	Comp	01121	CB	R76-15M
R103	1 kΩ	1%, 1/8 w	CbF	01295	CG1/8	R79-1K
R104	1 kΩ	5%, 1 w	WWVar	02111	50-1-1-102	RP33-1K

MECHANICAL PARTS

Item, Fig. 6-1	Description	Mfg. Code	Keithley Part No.
1	Probe Tip	80164	12908A
2	Probe Tip Connector Assembly	80164	15472A
3	Probe Body	80164	15606B
-	. Receptacle, bnc, Mil. No. UG-1094/U (Mfg. No. 31-221)	02660	CS-15
4	. Cable Lock	80164	15607A
5	. Cable Lock Nut	80164	15610A
6	. Strain Relief	80164	15467A
-	Ground Cable Assembly	80164	15471A
7	. Banana Plug (Mfg. No. 108-303)	74970	BG-5

MECHANICAL PARTS (Cont'd)

Item, Fig. 6-1	Description	Mfg. Code	Keithley Part No.
8	. Ground Lead	80164	15431A
9	Tube Shield and Co-ax Assembly	80164	15470A
10	Plug, uhf, Mil. No. 49190 (Mfg. No. 83-822)	02660	. CS-49
-	Plug Assembly with leads	80164	15475B
11	. Plug (Mfg. No. XLR-5-12C)	71468	CS-4

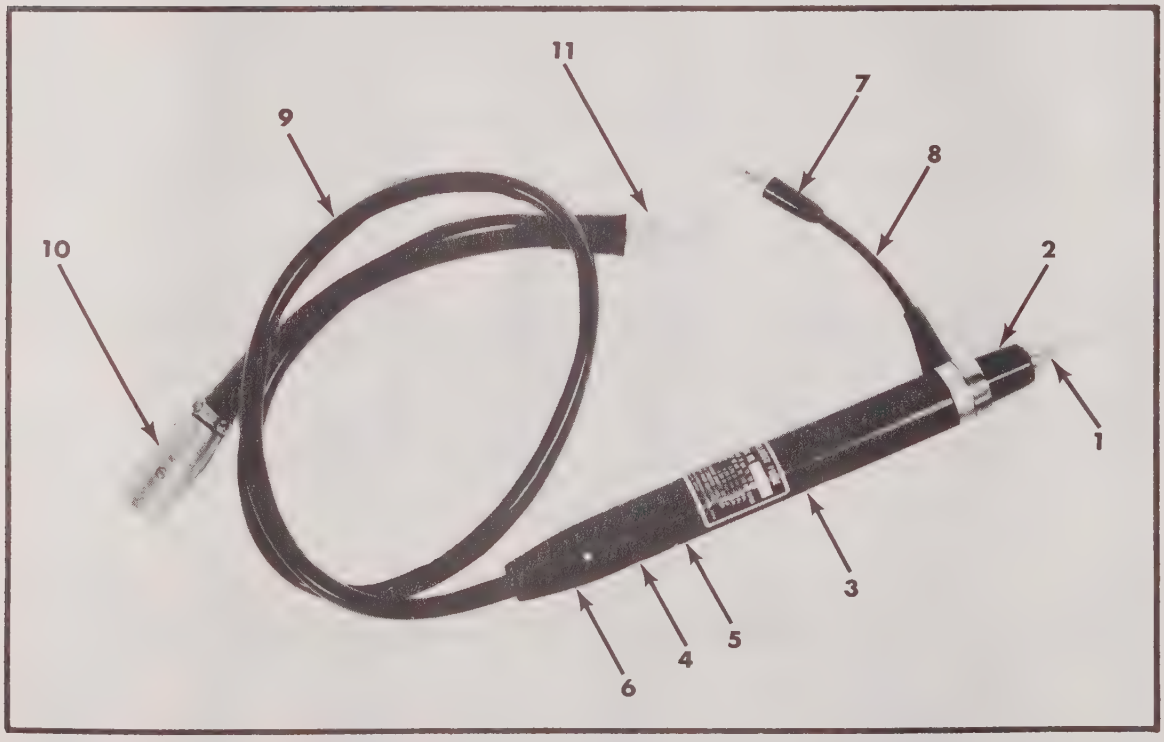


FIGURE 6-1. Model 1201 Cathode Follower Probe.

MODEL 1202 REPLACEABLE PARTS LIST

Item, Fig. 6-2	Description	Mfg. Code	Keithley Part No.
1	Probe Housing	80164	16500B
2	Ring	80164	16397A
3	Locking Ring	80164	16395A
4	Capacitor Adjusting Screw	80164	16399A
5	Movable Tube	80164	16394A
-	Resistor (within 16394A) 9 MΩ, 1%, 1/2 w, MtF (Mfg. No. CD1/2MR)	01295	R97-9M
6	Stud	80164	16522A
7	Probe Tip	80164	12908A
8	Fixed Tube	80164	16398A
-	Resistor (within 16398A) 124 Ω, 1%, 1/8 w, MtF (Mfg. No. CEA)	07716	R88-124
9	Connector, bnc type	80164	16523A
10	Ground Cord Assembly	80164	16525B
-	. Banana Plug (Mfg. No. 108-303)	74970	BG-5
-	. Cable	80164	16608B
-	Cable Assembly	80164	16520B
-	. Plug, bnc (Mfg. No. 5396)	91737	CS-117
-	. Plug, uhf, Mil. No. 49190 (Mfg. No. 83-822)	02660	CS-49
-	. Shielded Cable	80164	16518B

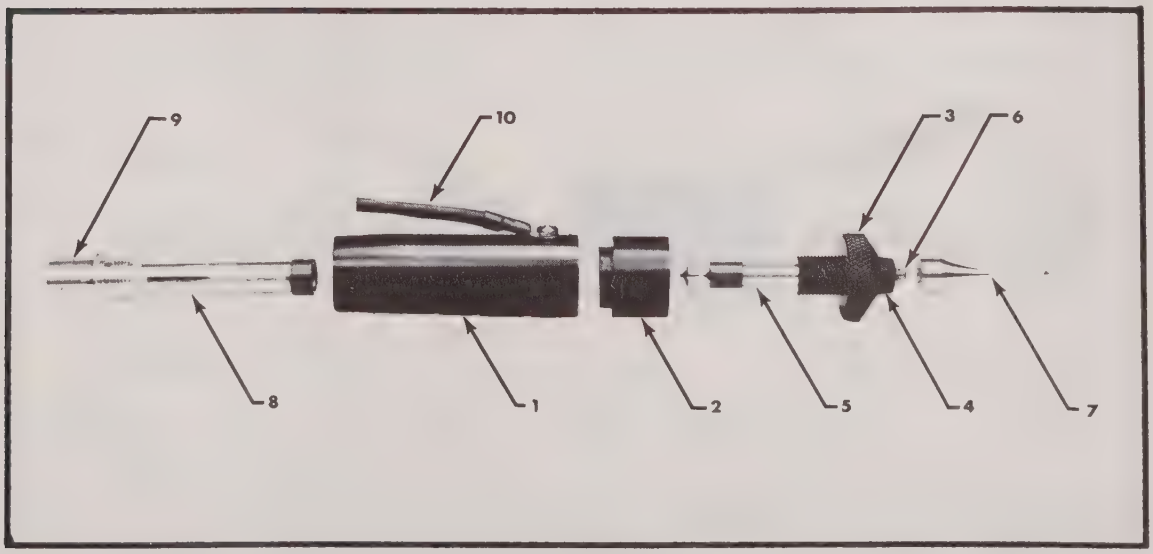


FIGURE 6-2. Model 1202 10:1 Divider Probe.

MODEL 1203 REPLACEABLE PARTS LIST

Item, Fig. 6-3	Description	Mfg. Code	Keithley Part No.
1	Probe Housing	80164	16503A
2	Ground Ring	80164	16504A
3	Locking Ring	80164	16506A
4	Bushing	80164	16502B
5	Movable Tube	80164	16507A
-	Resistor (within 16507A) 715 Ω, 1%, 1/2 w, MtF (Mfg. No. CEC)	07716	R98-715
6	Stud	80164	16521A
7	Probe Tip	80164	12908A
8	Fixed Tube	80164	16505A
9	Connector, bnc, Mil. No. UG-1094/U (Mfg. No. 31-221)	02660	CS-15
10	Ground Cord Assembly	80164	16524B
-	. Banana Plug (Mfg. No. 108-303)	74970	BG-5
-	. Cable	80164	16609B
-	Cable Assembly	80164	16520B
-	. Shielded Cable	80164	16518B
-	. Plug, bnc (Mfg. No. 5396)	91737	CS-117
-	. Plug, uhf, Mil. No. 49190 (Mfg. No. 83-822)	02660	CS-49

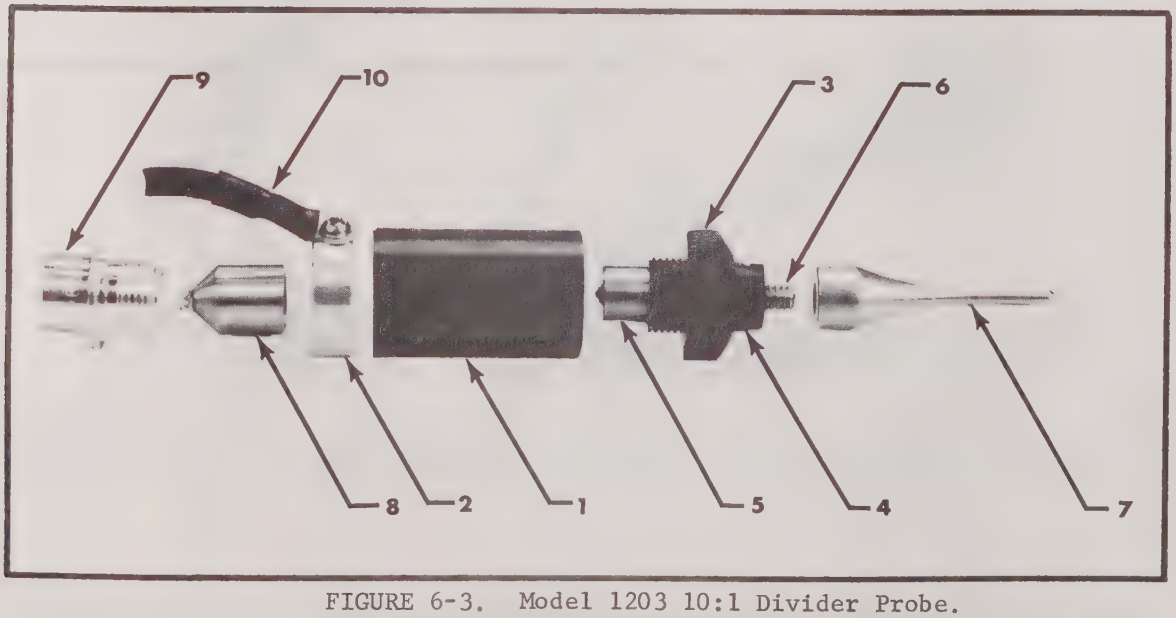


FIGURE 6-3. Model 1203 10:1 Divider Probe.

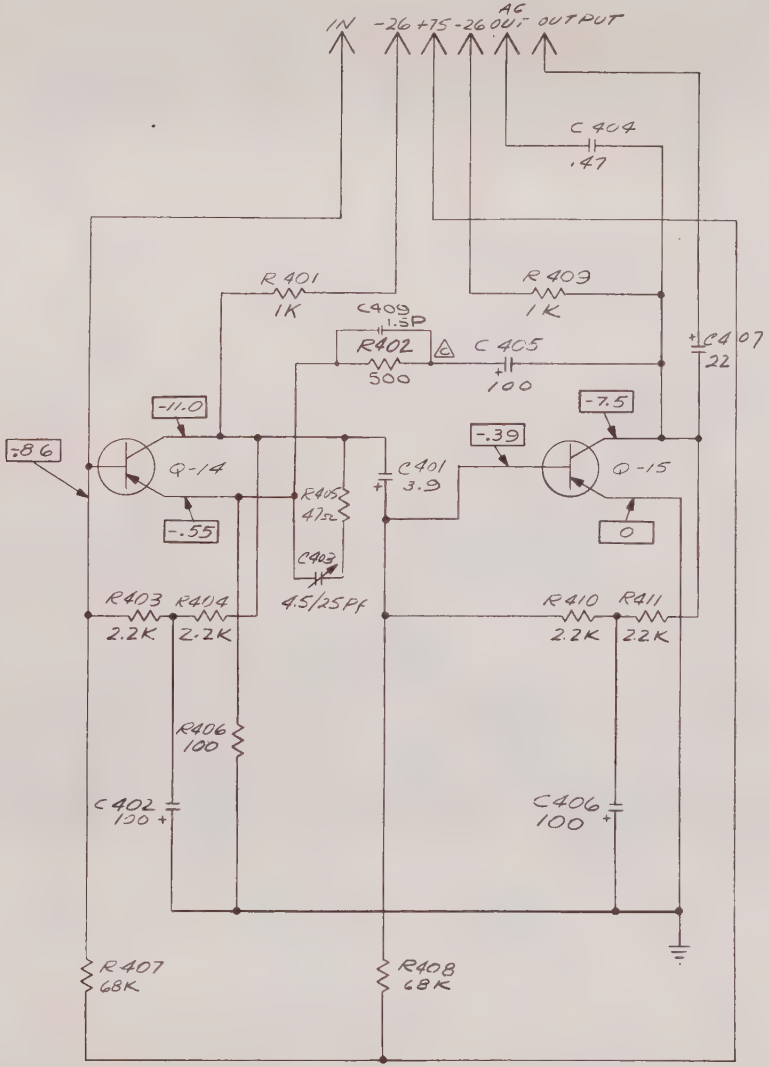
00011	Sylvania Electric Products, Inc. Buffalo Operations of Sylvania Electronic Systems Buffalo, N. Y.
00656	Aerovox Corp. New Bedford, Mass.
01121	Allen-Bradley Corp. Milwaukee, Wis.
01295	Texas Instruments, Inc. Semi-Conductor-Components Division Dallas, Texas
01686	RCL Electronics, Inc. Riverside, N. J.
01884	Dearborn Electronic Laboratories, Inc. Orlando, Fla.
02111	Spectrol Electronics Corp. San Gabriel, Calif.
02660	Amphenol-Borg Electronics Corp. Broadview, Chicago, Illinois
02735	RCA Semiconductor and Materials Division of Radio Corp. of America Somerville, N. J.
02777	Hopkins Engineering Co. San Fernando, Calif.
02985	Tepro Electric Corp. Rochester, N. Y.
04713	Motorola, Inc. Semiconductor Products Division Phoenix, Arizona
05079	Tansitor Electronics, Inc. Bennington, Vt.
05397	Kemet Dept. Union Carbide Corp. Cleveland, Ohio
07716	International Resistance Co. Burlington Div. Burlington, Iowa
08804	Lamp Metals and Components Department G. E. Co. Cleveland, Ohio
08811	G-C Electronics Co., Inc. Camden, N. J.
12065	Transitron Electronic Corp. East Boston, Mass.
12954	Dickson Electronics Corp. Scottsdale, Ariz.
13050	Potter Co. Wesson, Mill.
14655	Cornell-Dubilier Electric Corp Newark, N. J.
15909	Daven Co. Livingston, N. J.
28520	Heyman Mfg. Co. Kenilworth, N. J.
37942	Mallory, P. R., and Co., Inc. Indianapolis, Ind.
44655	Ohmite Mfg. Co. Skokie, Ill.
53021	Sangamo Electric Co. Springfield, Ill.
56289	Sprague Electric Co. North Adams, Mass.
58474	Superior Electric Co., The Bristol, Conn.
71400	Bussmann Mfg. Div. of McGraw-Edison Co. St. Louis, Mo.
71450	CTS Corp. Elkhart, Ind.
71468	Cannon Electric Co. Los Angeles, Calif.
71590	Centralab Division of Globe-Union, Inc. Milwaukee, Wis.

TABLE 6-2 (Sheet 1). Code List of Suggested Manufacturers. (Based on Federal Supply Code for Manufacturers, Cataloging Handbook H4-1.)

72619	Dialight Corp. Brooklyn, N. Y.
72699	General Instrument Corp. Capacitor Division Newark, N. J.
72982	Erie Technological Products, Inc. Erie, Pa.
74970	Johnson, E. F., Co. Waseca, Minn.
75042	International Resistance Co. Philadelphia, Pa.
75915	Littelfuse, Inc. Des Plaines, Ill.
76545	Mueller Electric Co. Cleveland, Ohio
79727	Continental-Wirt Electronics Corp. Philadelphia, Pa.
80164	Keithley Instruments, Inc. Cleveland, Ohio
80294	Bourns Laboratories, Inc. Riverside, Calif.
82879	Royal Electric Corp. Pawtucket, R. I.
83125	General Instrument Corp. Capacitor Division Darlington, S. C.
86684	RCA Electron Tube Division of Radio Corp. of America Harrison, N. J.
87216	Philco Corp. Lansdale Division Lansdale, Pa.
91637	Dale Electronics, Inc. Columbus, Nebr.
91737	Gremar Mfg. Co., Inc. Wakefield, Mass.
93958	Mucon Corp. Newark, N. J.
99942	Hoffman Electronics Corp. Semiconductor Division El Monte, Calif.

TABLE 6-2 (Sheet 2). Code List of Suggested Manufacturers. (Based on Federal Supply Code for Manufacturers, Cataloging Handbook H4-1.)

REVISIONS		
SYM	DESCRIPTION	DATE
A.		10-6-61
B	ECO 1744 I.S.	3/2/62
C	ECO 1860 RR	9/19/62



HIGHEST REFERENCE DESIGNATION		
R411	C409	Q-15
REFERENCE DESIGNATION NOT USED		
		Q1-Q13

NOTE:

1.) ALL RESISTANCE & CAPACITANCE SHALL BE DESIGNATED IN OHMS & MICROFARADS RESPECTIVELY UNLESS OTHERWISE NOTED.

2) DC VOLTAGES WHERE SHOWN ARE SUBJECT TO A NORMAL VARIATION OF ± 10%

B 120R 15400M 15400M
120 15000M 15000M

CONFIDENTIAL
PROPERTY OF

B

MATERIAL — FINISH —

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED

FRAC	DEC	ANG
± 1/64	± .005	± 30'

SCALE — NO REQD —

NEXT ASSY —

TITLE SCHEMATIC, TWO STAGE AC AMPLIFIER

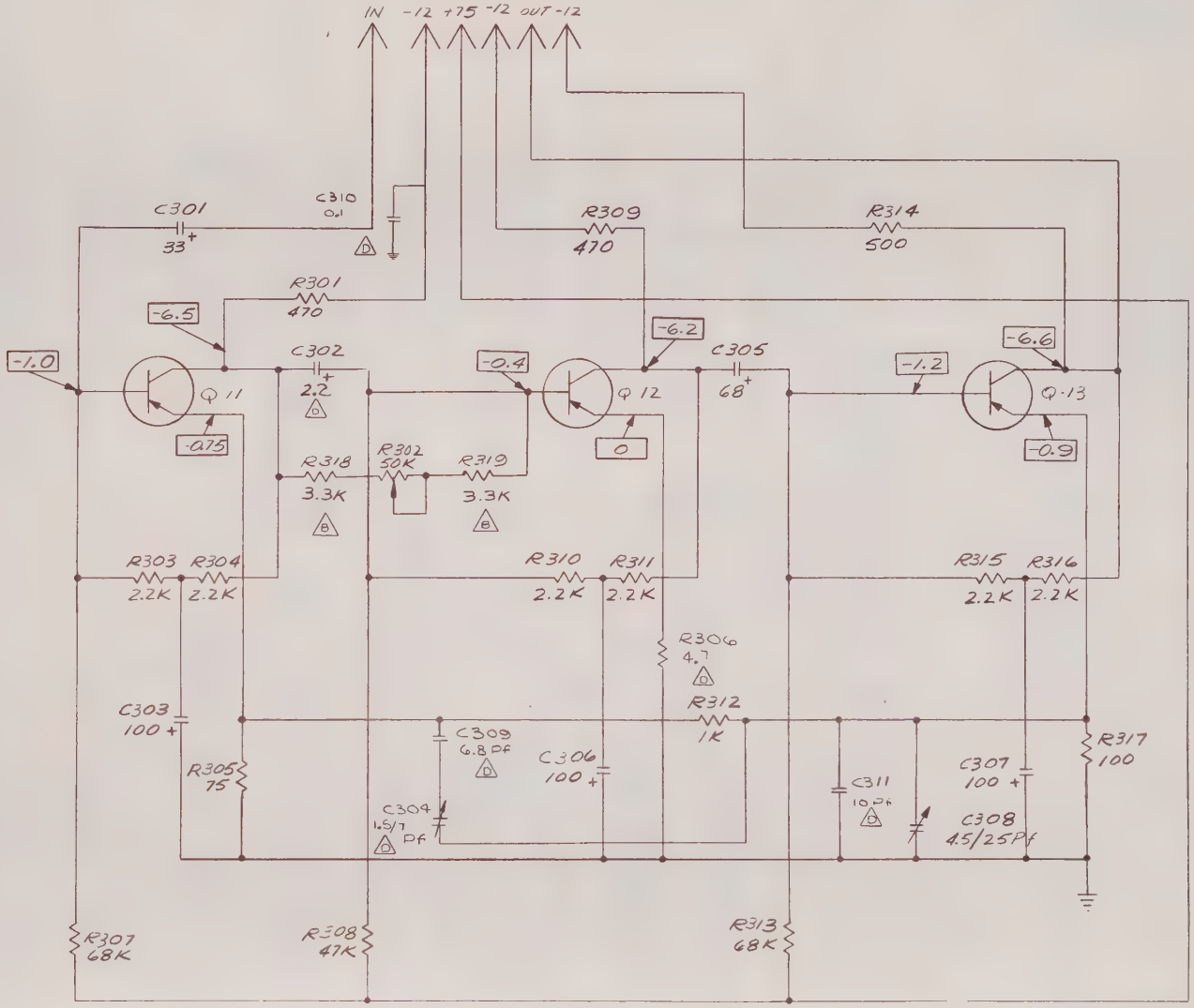
KEITHLEY INSTRUMENTS, INC. CLEVELAND, OHIO

DRAWN M. FURST DATE 5/17/62

CHECKED — DATE —

APPROVED [illegible] DATE 9-19-62

DRAWING NUMBER 150966



REVISIONS			
SYM	DESCRIPTION		DATE
A			
B	ECO 1580		12/03/62 GL
C	ECO 1744	I.S.	8/27/63
D	ECO 1860	RR	11-19-63

HIGHEST REFERENCE DESIGNATION		
C311	R320	Q-13

REFERENCE DESIGNATION NOT USED

+ Q10

NOTE:

1.) ALL RESISTANCE & CAPACITANCE SHALL BE DESIGNATED IN OHMS & MICRO FARADS RESPECTIVELY UNLESS OTHERWISE NOTED.

2) DC VOLTAGES WHERE SHOWN ARE SUBJECT TO A NORMAL VARIATION OF ± 10%

CONFIDENTIAL
PROPERTY OF KEITHLEY INSTRUMENTS INC
NOT TO BE DISCLOSED OR REPRODUCED EXCEPT AS AUTHORIZED

MATERIAL

FINISH

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED

FRAC	DEC.	ANG
± 1/64	± .005	± 30'

SCALE NO REQ'D

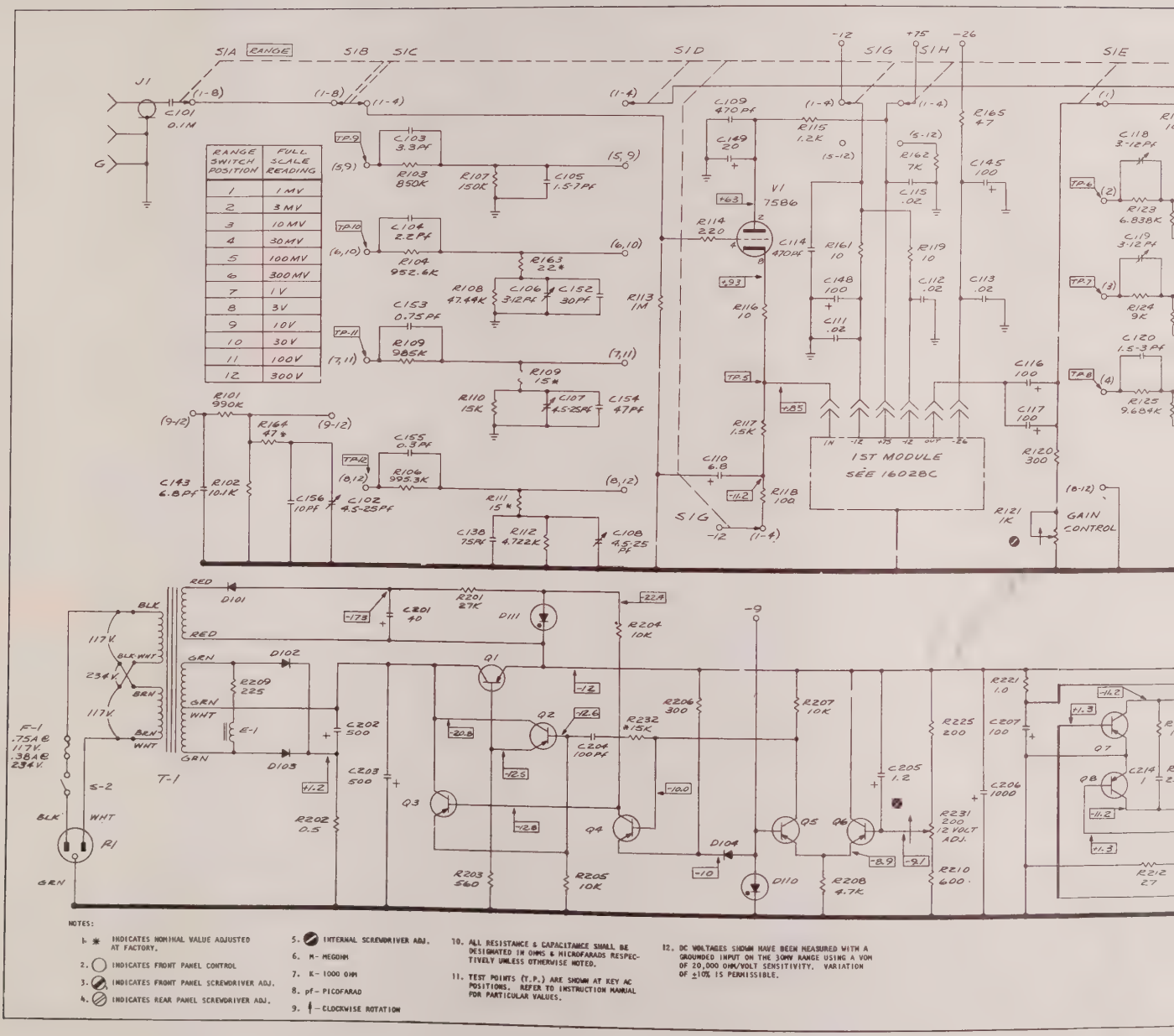
NEXT ASSY.

TITLE: SCHEMATIC, THREE STAGE AC AMPLIFIER

KEITHLEY INSTRUMENTS, INC. CLEVELAND, OHIO

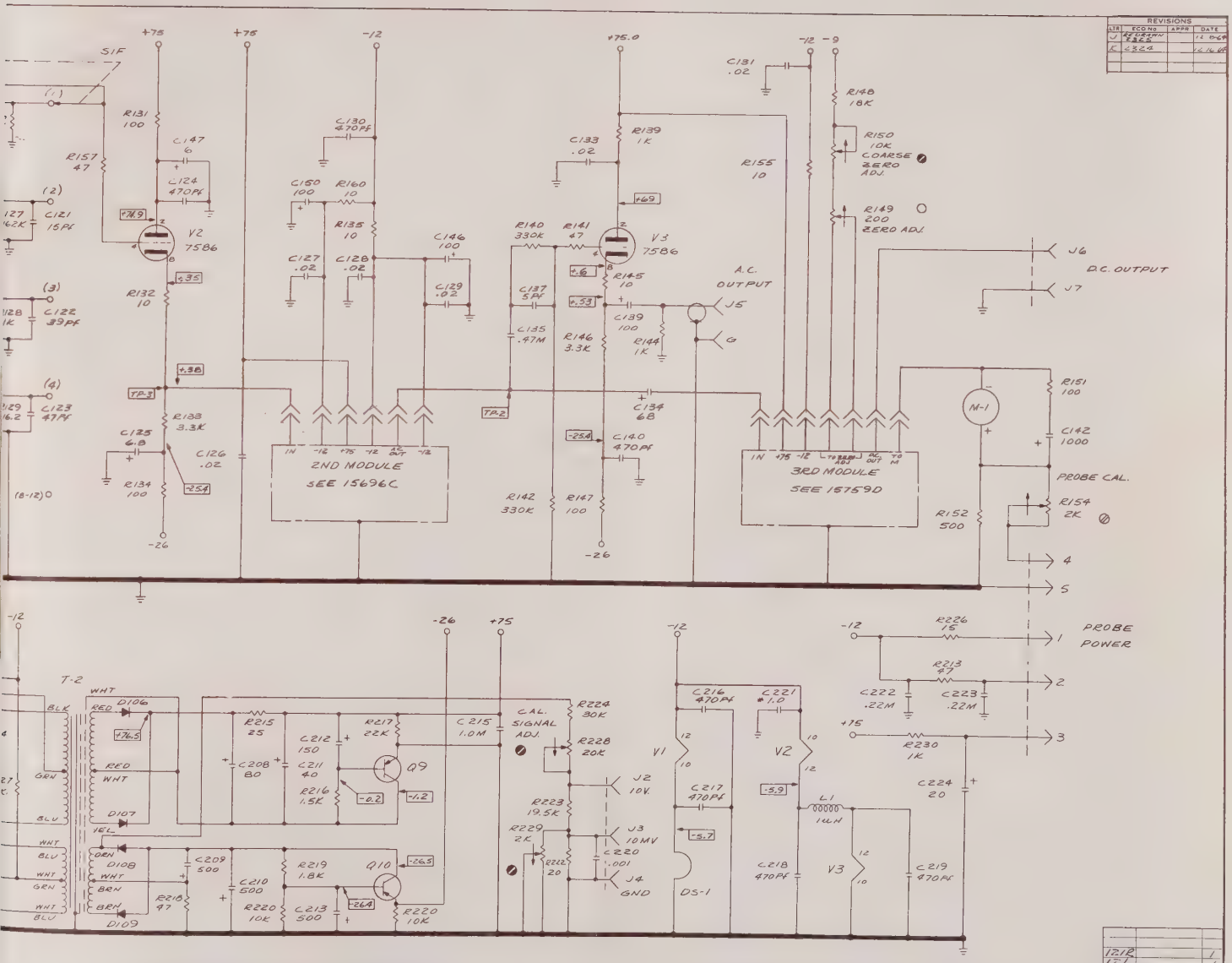
DRAWN	M FURST	DATE 5/16/62
CHECKED		DATE 6-8-62
APPROVED		DATE 9-19-62

DRAWING NUMBER 15098C



NOTES:

1. * INDICATES NOMINAL VALUE ADJUSTED AT FACTORY.
2. ○ INDICATES FRONT PANEL CONTROL
3. ⊘ INDICATES FRONT PANEL SCREWDRIVER ADJ.
4. ⊘ INDICATES REAR PANEL SCREWDRIVER ADJ.
5. ⊘ INTERNAL SCREWDRIVER ADJ.
6. M- MEGOHM
7. K- 1000 OHM
8. pf- PICOFARAD
9. ↻ - CLOCKWISE ROTATION
10. ALL RESISTANCE & CAPACITANCE SHALL BE DESIGNATED IN OHMS & MICROFARADS RESPECTIVELY UNLESS OTHERWISE NOTED.
11. TEST POINTS (T.P.) ARE SHOWN AT KEY AC POSITIONS. REFER TO INSTRUCTION MANUAL FOR PARTICULAR VALUES.
12. DC VOLTAGES SHOWN HAVE BEEN MEASURED WITH A GROUNDED INPUT ON THE 30MV RANGE USING A VOM OF 20,000 OHM/VOLT SENSITIVITY. VARIATION OF ±10% IS PERMISSIBLE.



REVISIONS			
LTR	ECO NO	APPR	DATE
J	RELEASED		12-8-64
K	4324		12-14-64

REFERENCE DESIGNATION NOT USED					LIST OF REFERENCE DESIGNATION					
R130	R136	R137	R143	R148	R165	R232	DII	C156	C224	Q10
R153	R156	R158	R159	R211	F1	T-2	V3	DS-1	P1	N1
	C144	C132	C141		J8	L1	S2	E1		
	C151									
	D105									

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			DRN V.I.F.	DATE 11-16-64
FRAC	DEC	ANG	CKD M.F.	DATE 12-1-64
± 1/64	± .005	± 1°	ENG APPR	DATE
			PLOT RELEASE	DATE
DO NOT SCALE			PROD RELEASE (1st)	DATE 12-17-64

KEITHLEY INSTRUMENTS CLEVELAND OHIO

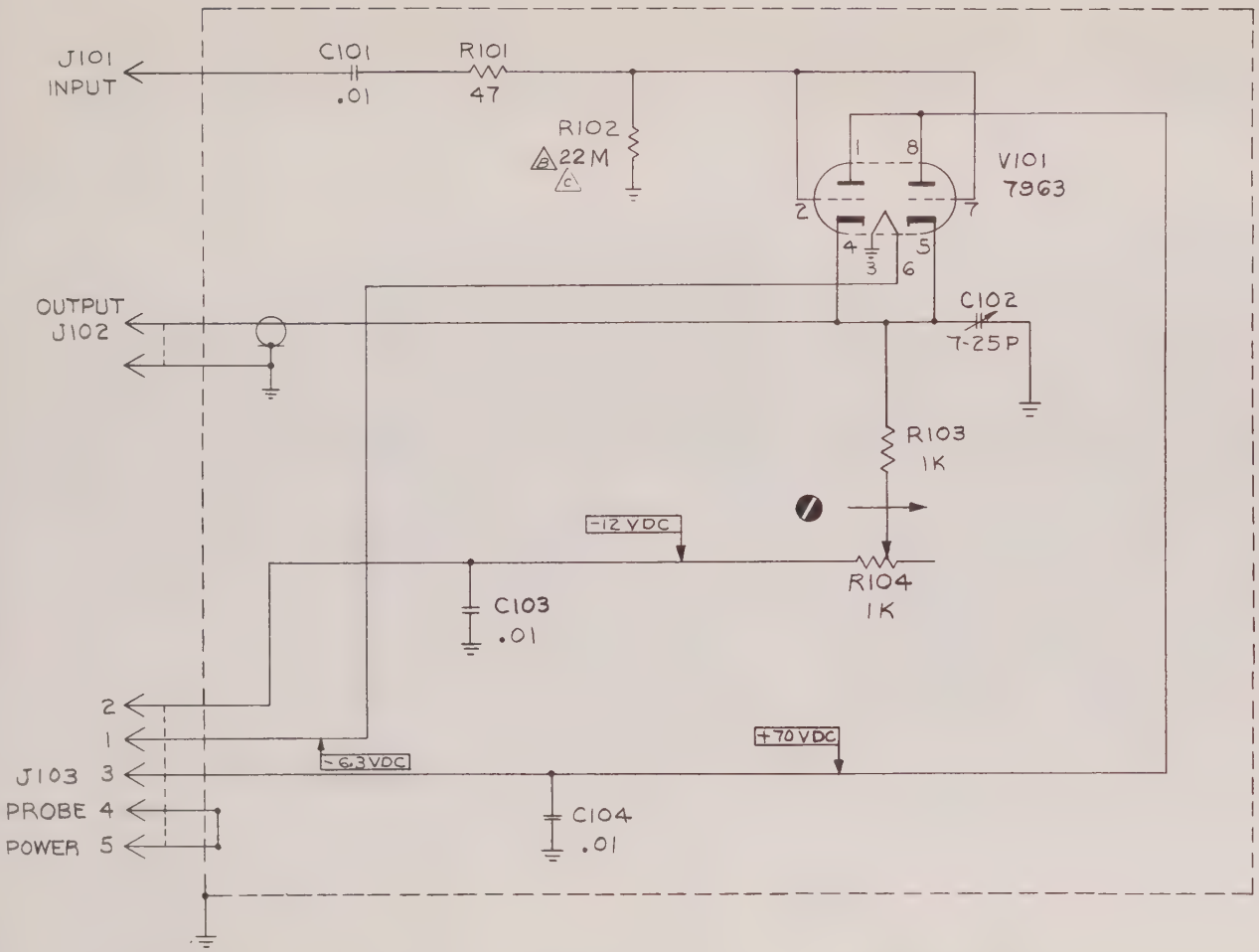
TITLE SCHEMATIC

MATERIAL

FINISH

PART NUMBER 15760H

12/R 1
12/1 1
MODEL NEXT ASSEMBLY USED ON



NOTES:
1. ALL RESISTANCE & CAPACITANCE SHALL BE DESIGNATED IN OHMS & MICROFARADS RESPECTIVELY UNLESS OTHERWISE NOTED.
2. ↑ CLOCKWISE ROTATION.
3. ⊘ INDICATES INTERNAL SCREWDRIVER ADJ.
4. * INDICATES NOMINAL VALUE.
5. K=1000 M=10^6 P= PICOFARADS

REVISIONS			
LTR	ECO NO.	APPR.	DATE
A	REDRAWN		8/25/63
B	2065		4/9/64
C	2110		7/21/64

HIGHEST REF. DESIG. USED				REF. DESIG. NOT USED			
R104	C104	V101	J103				

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NOT TO BE USED OR REPRODUCED EXCEPT AS AUTHORIZED BY THE COMPANY

MODEL	NEXT ASSEMBLY	QUAN.
1201		1

USED ON

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		
FRAC.	DEC	ANG
± 1/64	± .005	± 1°
—	—	—
DO NOT SCALE		

DRN.	I. S.	DATE 8/25/63
CKD.	M.F.	DATE 8/26/63
ENG. APPR.	R.S.	DATE 8-28-63
PILOT RELEASE		DATE 9-24-63
PROD. RELEASE		DATE

KEITHLEY INSTRUMENTS
CLEVELAND, OHIO

MATERIAL
FINISH

TITLE SCHEMATIC
CATHODE FOLLOWER PROBE

PART NUMBER 15483C

WARRANTY

We warrant each of our products to be free from defects in material and workmanship. Our obligation under this warranty is to repair or replace any instrument or part thereof (except tubes and batteries) which, within a year after shipment, proves defective upon examination.

To exercise this warranty, contact your Keithley field engineering representative. You will be given assistance and shipping instructions.

REPAIRS AND RECALIBRATION

Keithley Instruments and its international distributors maintain complete repair facilities.

To insure prompt repair or recalibration service, please contact your Keithley field representative before returning the instrument.

Estimates for repairs, normal recalibrations, and calibrations traceable to the National Bureau of Standards are available upon request.

CHANGE NOTICE

January 25, 1965 MODEL 121 TRUE RMS VOLTMETER

Page 6. Add the following after paragraph 2-3:

ZERO ADJUSTMENT: Set the Range Switch to the 300-volt position. Use the ZERO Control to set the meter needle within the red band around the zero position. For maximum zero stability, allow 30 minutes for warm-up. If the voltmeter is re-zeroed after warm-up, the meter needle should lie within the red band for at least one hour. Note that the zero does not have to be exactly set. Even if the needle is at the edge of the red band, less than 0.5% error due to zero drift is introduced for a full-scale reading. If the needle is set exactly at zero, no error due to zero drift will occur anywhere along the scale.

NOTE

When the Voltmeter is overloaded, the thermocouple detector will recover exponentially. If the meter is zeroed before complete recovery -- approximately two or three minutes -- a zero drift will appear to take place. This apparent zero drift is actually a return to normal position by the detector.

Page 6-11. Change to the following:

---	Thermocouple Matched Assembly	80164	18449B
TC1	**Thermocouple	-----	TM-3
TC2	**Thermocouple	-----	TM-3

**Order TC1 and TC2 as matched pair, part 18449B, only.

KEITHLEY INSTRUMENTS, INC.
12415 EUCLID AVENUE CLEVELAND, OHIO 44106